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Ontario Geological Survey
Open File Report 6055

Quaternary Geology of the Wawa Area, Northeastern Ontario

2001

101-04586/

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ONTARIO GEOLOGICAL SURVEY

Open File Report 6055

Quaternary Geology of the Wawa Area, Northeastern Ontario

by

T.F. Morris

2001

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Map 2574 (coloured)-Quaternary geology, Hawk Junction-Michipicoten River area. Scale 1:50 000.

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*Miscellaneous Release—Data 73

Miscellaneous database related to the Wawa Quaternary geology mapping project, northeastern Ontario; by T.F. Morris

This release consists of overburden data sampled to characterize Quaternary deposits in the Wawa area of northeastern Ontario. In addition, data for glacial striae, till fabric analysis, glaciofluvial paleocurrent analysis and altimeter recordings are included. This data release consists of 10 sets of data stored as both ASCII (.txt) and Microsoft® Excel® (.xls) files. The data are grouped into the following files:

Intro:	Summary list of abbreviations
AppA:	Sample site locations
AppB:	Material geochemistry summary
AppC:	Material carbonate analysis summary
AppD:	Material textural data
AppE:	Pebble data
AppF:	Striae orientation
AppG:	Till geochemistry summary by bedrock terrane
AppH:	Till fabric analysis, glaciofluvial paleocurrent data
AppI:	Altimeter data

This diskette is available separately from the report.

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ABSTRACT

Quaternary materials in the Wawa area were deposited during the Late Wisconsinan by the Labrador sector of the Laurentide Ice Sheet. The distribution and orientation of ice flow indicators illustrate a regional southwest ice flow between 159° and 240°. This flow event also resulted in the deposition of a thin (less than 1 m) subglacial till over much of the study area. The properties of this till largely reflect those of the local bedrock terrane.

As the ice sheet began to thin and retreat from the study area, ice flow was locally controlled by bedrock topography and a younger set of striae, cross-cutting the older regional set, were abraded into the bedrock surface. These striae indicate a more westerly flow of between 220° and 290°. Retreat of the ice margin was to the northeast as defined by the orientation and distribution of recessional moraine and some meltwater channels.

During ice retreat, subglacial meltwater abraded "S" forms (potholes, sichelwannen, spindles) into the bedrock surface. Ice-contact stratified drift was deposited as recessional moraine, eskers and dead ice topography. Glaciofluvial outwash was deposited primarily within bedrock controlled valleys directly from the ice margin or from wasting ice detached from the ice sheet.

Also during retreat, the ice sheet was fronted by glacial meltwaters associated with the Lake Superior basin or by glacial meltwater empounded by the ice sheet and topographically higher ground. Features associated with all 7 prominent lake stages of the Lake Superior basin, are preserved within the study area.

Peat, recovered from a bog located within the surface of a terrace associated with the highest glacial lake in the Superior basin, was radiocarbon dated at 9759± 170 BP (GSC 5914). A caribou antler, recovered from a terrace associated with Glacial Lake Minong III was radiocarbon dated at 8820± 80 BP (TO-6213).

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INTRODUCTION

Study Location

Wawa is located 225 km north of Sault Ste. Marie and 335 km west of Timmins (Figure 1). The study area covers approximately 3263 km^2 and is represented by 3, 1:50 000 scale National Topographic System (NTS) map sheets, including: the Hawk Junction map sheet (NTS 42C/2) bounded by longitudes 84°30′W, 85°00′W and latitudes 48°00′N, 48°15′N; the Manitowik Lake map sheet (NTS 42C/1), bounded by longitudes 84°00′W, 84°30′W and latitudes 48°00′N, 48°15′N; the southern half of the Franz map sheet (NTS 42 C/8), bounded by longitudes 84°00′W, 84°30′W and latitudes 48°15′N, 48°22′N; the northern half of the Kinniwabi Lake map sheet (NTS 41 N/16) bounded by longitudes 84°00′W, 84°30′W and latitudes 47°50′N, 48°00′N; and the northern third of the Michipicoten Harbour map sheet (NTS 41 N/15) bounded by longitudes 84°30′W, 85°00′W and latitudes 47°53′N, 48°00′N.

Project History

Surficial geology mapping and overburden sampling was initiated by the Ontario Geological Survey (OGS) in the west-central part of the study area in 1990 and the northeastern part in 1991 (Figure 1; Morris 1990, 1991, 1992a, 1992b). The purpose of this work was to provide a framework for exploration programs using overburden as an exploration media and to complement bedrock mapping of the Michipicoten greenstone belt and surrounding area (Sage 1994). In 1990, overburden materials were mapped and till "B" horizon material was sampled from the Hawk Junction map sheet (NTS 42 C/2; Morris 1990, 1992a). In 1991, overburden materials were mapped and till "B" horizon material sampled from an area shown on the southern half of the Franz sheet (NTS 42 C/8) and the northern half of the Manitowik Lake sheet (NTS 42 C/1; Morris 1991, 1992b). Materials were sampled at a regional scale in both projects (i.e., an attempt was made to collect one sample per 5 km^2). Orientation surveys were also completed to determine the characteristics of material dispersed by glaciers and to establish geochemical and heavy mineral signatures over known mineralization.

In 1993, a local prospector recovered diamonds while panning for gold in the Michipicoten River area south of Wawa. This prompted the OGS to conduct a regional modern alluvium sampling program to determine the types, distribution and relative concentration of kimberlite indicator minerals (KIMs; Morris et al. 1994). Kimberlite is the rock-type most commonly associated with diamonds and the indicator minerals are thought to be unique to this rock type (Dawson 1984, 1987). The area sampled included the area mapped in 1990 and 1991 and also the northern third of the Michipicoten Harbour map area (NTS 41 N/15; Figure 1). Samples of humus and till "B" and "C" horizon material were collected in addition to modern alluvium. Overburden mapping for the northern third of the Michipicoten Harbour map area was also completed (Morris

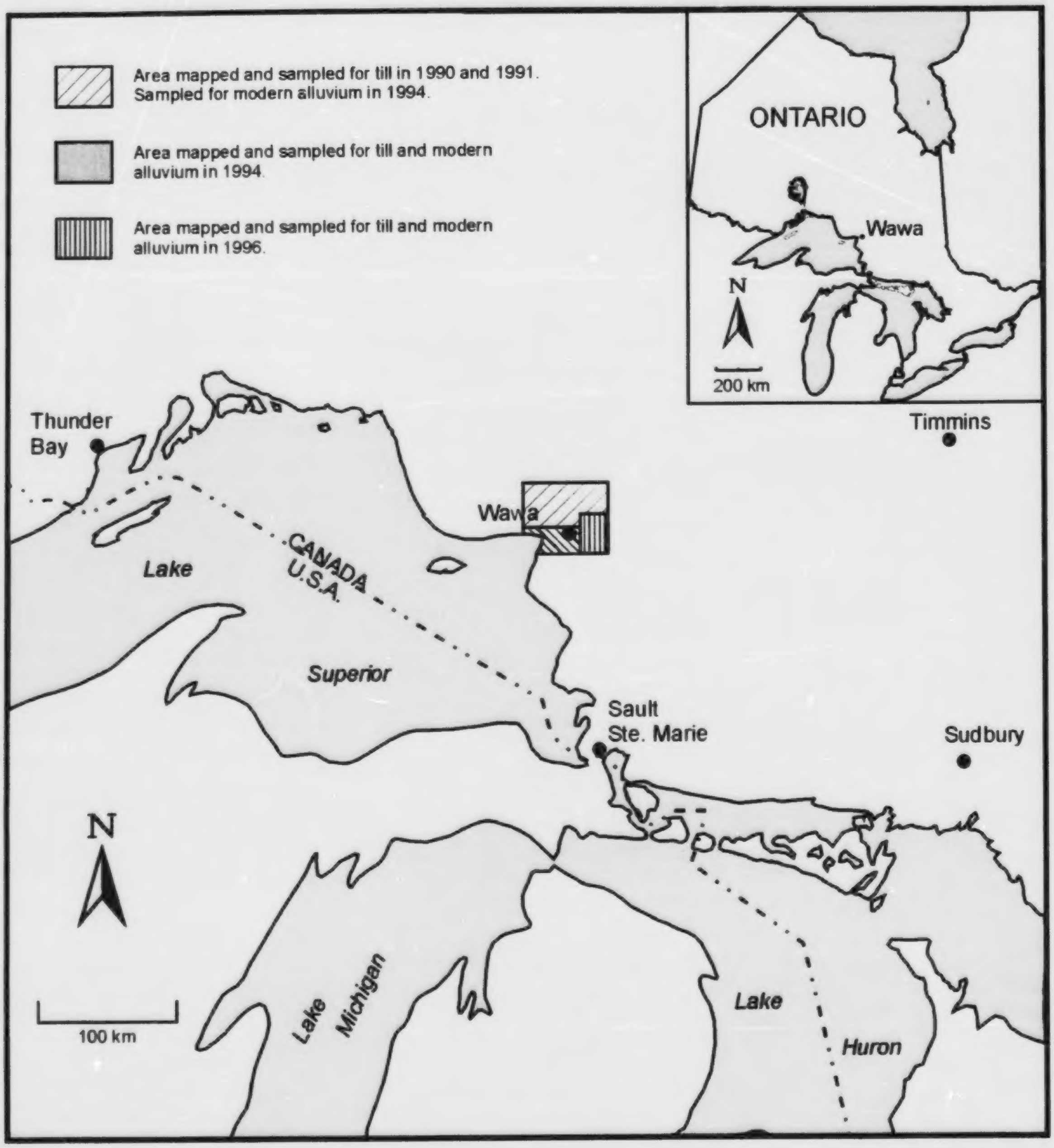

Area mapped and sampled for till in 1990 and 1991. Sampled for modern alluvium in 1994.
Area mapped and sampled for till and modern alluvium in 1994.
Area mapped and sampled for till and modern alluvium in 1996.
ONTARIO
Wawa
N
200 km
Thunder Bay
Timmins
Wawa
CANADA
U.S.A.
Lake
Superior
Sault Ste. Marie
Sudbury
N
100 km
Lake Michigan
Lake
Huron

Figure 1. Study area location.

1994).

Additional modern alluvium sampling in the Kinniwabi Lake area was completed in 1996 to augment previously collected KIM data (Morris et al. 1997). In addition, overburden mapping and collection of humus and till "B" and "C" horizon material was completed for the area covered by the southern half of the Manitowik Lake map area (NTS C/1) and the northern half of the Kinniwabi Lake map area (NTS 41 N/16; Morris 1996).

In 1999, an OGS open file report was published that summarized all geochemical and heavy mineral data (Morris 1999a, 1999b) for the Wawa area. Additional mineral exploration targets based on samples with anomalous geochemical values and till heavy mineral signatures were delineated within the report. A summary list of all materials collected from the Wawa area since 1990 is presented in Appendix A.

PURPOSE

Accompanying this report are OGS maps 2573 (back pocket) and 2574 (back pocket) and, as a separate publication, Miscellaneous Release—Data 73 (Morris 2001). The data presented in Morris (2001) are summaries of all previously unreleased overburden geochemical, carbonate, grainsize and pebble lithology data. Selected geochemical and pebble lithology data sets, used to define potential areas of mineralization, were previously released in Morris (1999a, 1999b). Glacial striae orientation, till fabric analysis, glaciofluvial paleocurrent data and altimeter data are also included within Morris (2001). Due to the size of the files, only the sample site locations are included within this report (Appendix A). The additional data, included within Miscellaneous Release—Data 73, are the following files:

Intro:	Summary list of abbreviations
AppA:	Sample site locations
AppB:	Material geochemistry summary
AppC:	Material carbonate analysis summary
AppD:	Material textural data
AppE:	Pebble data
AppF:	Striae orientation
AppG:	Till geochemistry summary by bedrock terrane
AppH:	Till fabric analysis, glaciofluvial paleocurrent data
AppI:	Altimeter data

These files are in both ascii.txt and .xls format.

This report defines the distribution and characteristics (physical, lithological, mineralogical and geochemical) of the different overburden materials within the Wawa area. The area's potential for gold, base metal, pegmatite (rare-earth) mineralization and kimberlite (diamond) have previously been reported in Morris (1999a), Morris et al. (1994), Morris et al. (1997) and Morris et al. (1998). In addition, all orientation surveys conducted in the Wawa area and their relevance to the exploration industry are summarized in Morris (1999a) and Morris and Kaszycki (1997). In addition to providing relevant information to the mineral exploration and environmental industries, overburden maps are useful for land use applications such as identification of potential sources of granular aggregate, engineering, fisheries, forestry and soil studies.

PHYSIOGRAPHY AND DRAINAGE

Topography of the study area is described as moderate to undulating (Boissoneau 1966, 1968) and moderate to severely rugged (Gartner and McQuay 1979). Local relief ranges up to 230 m.

The study area is located south of the Great Lakes-Hudson Bay regional drainage divide and all water within the study area flows south to the Lake Superior basin. Three major drainage basins occur within the study area. These include, from west to east: the Doré, Magpie and Michipicoten rivers (the Michipicoten being the largest). The orientation of many of the major lakes within these drainage basins is controlled by bedrock structural features such as deformation zones (e.g., Emily Bay, Dog Lake and McKewen Lake deformation zones; Heather and Buck 1988).

BEDROCK GEOLOGY

The Wawa region lies within the Wawa subprovince of the Canadian Shield. The study area straddles much of the Michipicoten greenstone belt. The belt has an average width of 38 km and extends inland 150 km to the northeast from the Lake Superior shore. The greenstone belt consists largely of supracrustal rocks of Archean age, however, stocks of younger, Archean-aged granite also occur. These younger Archean granitic rocks also surround the greenstone belt (Figure 2).

The Kapuskasing Structural Zone (KSZ) extends east from the shore of Lake Superior, northeast through Kapuskasing and into James Bay (Figure 2). This structure is significant as it consists of fractured crustal material that may host kimberlitic rock (Boland and Ellis 1989). Structures associated with the KSZ include northeast striking Proterozoic lamprophyre dikes formed by alkalic magma emplacement (Sage 1994).

The Precambrian geology of the Michipicoten greenstone belt, and related studies, are summarized by Sage (1994). There are 4 major sedimentary and metavolcanic rock types recognized within the Michipicoten greenstone belt. These are: 1) intermediate to mafic metavolcanic rocks; 2) intermediate to felsic metavolcanic rocks; 3) clastic metasedimentary rocks; and 4) chemical metasedimentary rocks.

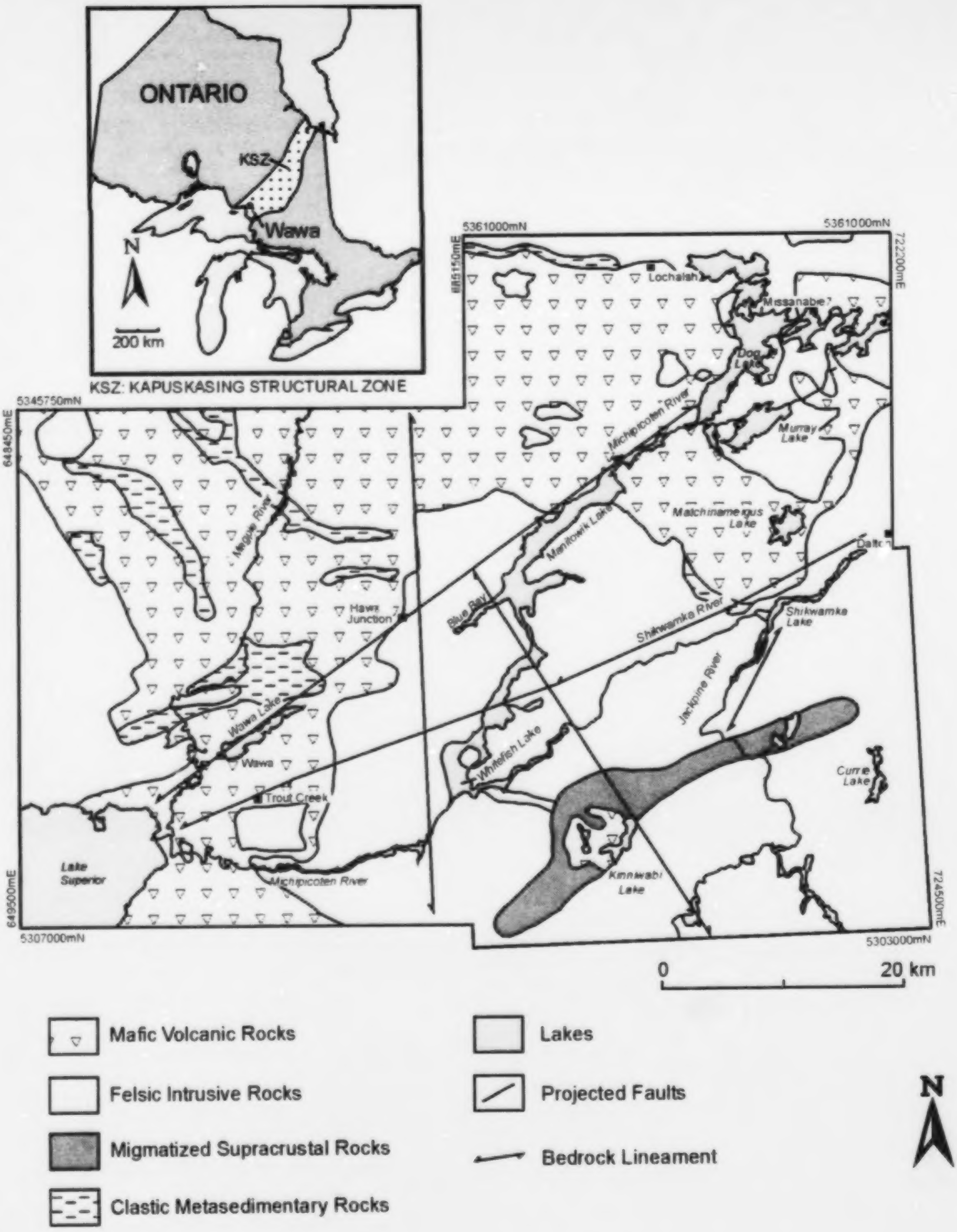

ONTARIO
KSZ
Wawa
N
200 km
KSZ: KAPUSKASING STRUCTURAL ZONE
5361000mN
5361000mN
685150mE
722200mE
5345750mN
648450mE
Lochalsh
Missanabie
Dog Lake
Michipicoten River
Murray Lake
Matchinameigus Lake
Manitowik Lake
Dalton
Magpie River
Hawk Junction
Blue Bay
Shikwamka River
Shikwamka Lake
Jackpine River
Wawa Lake
Wawa
Whitefish Lake
Trout Creek
Currie Lake
Kinniwabi Lake
Lake Superior
Michipicoten River
649500mE
724500mE
5307000mN
5303000mN
0
20 km
Mafic Volcanic Rocks
Felsic Intrusive Rocks
Migmatized Supracrustal Rocks
Clastic Metasedimentary Rocks
Lakes
Projected Faults
Bedrock Lineament
N

Figure 2. Bedrock geology of the Wawa area (from Sage 1994). Location of the Kapuskasing Structural Zone (KSZ) is illustrated on the inset map.

Intermediate to mafic metavolcanic rock is exposed throughout most of the greenstone belt. The intermediate to felsic metavolcanic rocks are less widespread and restricted to belts and blocks scattered across the greenstone belt. The intermediate to mafic and felsic metavolcanic rocks were deposited during 2 major, and a third minor, volcanic cycles. The materials of the 2 major volcanic cycles range in composition from tholeiitic basalt to calc-alkalic felsic volcanics (Thurston 1986). Materials of the third minor volcanic cycle represent basaltic to peridotitic komatiite volcanism followed by calc-alkalic felsic volcanism (Sage and Heather 1991).

Metasedimentary rocks are more common in the western part of the study area than in the east. They were deposited within a marine alluvial fan depositional environment and were subsequently buried by materials of a shallow braided stream environment (Neale 1981, Thomas 1984). The metasedimentary rocks consist of either conglomerate, wacke or siltstone or argillite (Sage and Heather 1991).

Iron formation is the dominant chemical metasedimentary rock found within the greenstone belt and most commonly is found in the southwestern, central and northeastern parts of the study area. The iron formation consists of 5 facies that include, in ascending order: a) siderite (carbonate facies); b) pyrite (sulphide facies); c) chert-magnetite wacke (oxide facies); d) argillite-pyrite-graphite; and e) a facies where calcite occasionally substitutes for siderite (Sage and Heather 1991). Origin of the iron formation is summarized by Sage and Heather (1991).

Several stocks are scattered across the greenstone belt and range in composition from trondhjemite to granodiorite to granite. All are younger than the surrounding supracrustal rocks and may have been emplaced at the same time as the felsic intrusive rocks external to the greenstone belt.

Surrounding the supracrustal rocks are felsic intrusive rocks that range in composition from tonalite and trondhjemite to granite (Sage and Heather 1991). Felsic intrusive rocks on the south side of the greenstone belt are older than the same rocks on the north side. Within the felsic intrusive rocks to the southeast is a thin belt of migmatized supracrustal rocks (Ontario Geological Survey 1991).

METHODS

Field

Overburden Mapping

The types and distribution of overburden are defined by mapping of the surficial geology. For this study, mapping was completed at a 1:50 000 scale. The initial step to mapping included identifying landforms from satellite (LANDSAT 5-MSS, Bands 1,2,4, early summer) imagery and 1:15 840 scale black and white aerial photographs. Material types were then inferred for the various landforms and many of the preliminary interpretations were field checked. Observations from 3424 recorded field stops were made over 4 summers (Morris 1990, 1991, 1994, 1996). Site locations were determined from the use of the black and white aerial photographs, 1:50 000 scale topographic maps or the use of a Garmin global positioning system (GPS).

At each field observation site, characteristics of the surrounding landscape (topography, overburden thickness, bedrock types, major landform, drainage, vegetation cover) and material type (type, grain size, colour, structure, plasticity, cementation, pebble types) were noted. Colour was determined with the aid of a Munsell soil colour chart. Till fabric analysis was completed at 5 sites, and paleocurrent measurements at 38 sites. Exposed bedrock surfaces were checked for ice flow indicators (glacial striae, grooves, chattermarks and whaleback forms). Determination of glacial ice flow direction was accomplished by measuring the orientation of these indicators with a Brunton compass.

The elevation of landform surfaces (such as terraces) were determined through the use of: 1) a Wallace and Tiernan precision aneroid barometer accurate to ± 2 m; 2) 1: 50 000 scale NTS topographic map sheets (50 foot contour interval); or c) 1:20 000 scale Ontario Base Map Sheets (10 m contour interval).

Overburden Sampling

Several different sampling strategies were employed for this project. The vast majority of samples were collected to evaluate the mineral potential of the region. To do this, 2 different types of material were collected and processed. The first material type, modern alluvium, was collected at a regional scale to provide data on the types, distribution and relative concentration of heavy minerals. Heavy mineral information is useful in evaluating a region's kimberlite (diamond), base metal, gold and rare-element pegmatite potential.

Sampling of modern alluvium provides a means of gaining a fast, relatively inexpensive heavy mineral signature for individual drainage basins. Modern alluvium's heavy mineral signature is derived from bedrock and overburden; this is influenced by the subsequent transportation and deposition history of the eroded material. Of particular importance, however, is the recognition that lakes within the drainage basins act as sediment traps, restricting the down drainage transport of heavy minerals. Therefore, when modern alluvium sample sites were chosen for this study, an attempt was made to maximize the length of stream section between sample site and a lake. This maximizes the area of drainage basin sampled by the stream.

Modern alluvium was collected from bars or sediment traps within streams where heavy minerals tend to concentrate. Material was screened with a 7 mm mesh, steel sieve to remove the coarse fraction. A minimum of 10 kg of the <7 mm sized material was collected at each site. A minimum of 50 pebbles were collected from the >7 mm sized fraction for determination of pebble lithology.

Till was the second type of material collected to evaluate the region's mineral potential. The till consisted of both lodgment and subglacial flow types. Regional till sampling and analysis defines the distribution and relative concentration of different elements, heavy minerals and pebble lithologies contained within "B" and "C" horizon till samples. From this data, regional background concentrations can be derived and anomalous values of various till constituents can be evaluated in terms of potential exploration targets for kimberlite (diamond), base metal, gold and rare-element pegmatite.

Till samples were collected from a hypothetical grid placed over the study area. The grid consisted of individual 5 km^2 blocks and as many of these blocks as possible were sampled. At each site, approximately 200 g of humus and till "B" and "C" horizon material, a 10 kg till "C" horizon bulk sample and a pebble sample were collected. The till "B" and "C" horizon materials were screened using a 7 mm mesh sieve. Approximately 200 g of the <7 mm mesh material was collected for geochemical analysis as was 200 g of humus. The 10 kg sample of "C" horizon material was submitted for heavy mineral concentration and subsequent analysis. Determination of pebble lithology was made on a minimum of 50 pebbles collected from the material retained on the sieve.

A second sampling strategy was used to evaluate the properties of other material types recognized in the area and to provide information on the characteristics of glacially dispersed materials. To evaluate the properties of other material types in the region, the geochemical, heavy mineral, pebble lithology and texture of eolian material, fine-and coarse-grained glaciolacustrine material, glaciofluvial outwash, glaciofluvial ice-contact stratified drift and till (specifically flow till associated with glacial retreat) were determined.

To characterize how materials are dispersed from a known source by glaciers, several orientation surveys were completed. These surveys focussed on prominent bedrock contacts that are aligned perpendicular to regional ice flow. Two surveys were conducted over sites of known mineralization; one a gold and the other a base metal occurrence. These surveys involved the sampling of till at 200 m intervals up-ice, over and down-ice of the bedrock contacts or areas of mineralization. The surveys were then used to: 1) determine the geochemical signature of till associated with base metal and gold mineralization; and 2) characterize the scale and form of dispersal associated with the different bedrock contacts.

Analytical Methods

Geochemical

Analytical methods, multi-element suites and detection limits used in the geochemical analyses of humus, as well as "B" and "C" horizon till are summarized in Morris (1999a, 1999b). Standard and duplicate geochemical data are summarized in Morris (1999b). Geochemical results for humus and "B" and "C" horizon subglacial till samples are summarized in Morris (1999a). Geochemical values for all other materials are summarized in this report and in Morris (2001, Appendix B).

Carbonate Analysis

Carbonate determination was made on a limited number of "B" and "C" horizon till samples collected in 1990 and 1991. Carbonate content was determined from analysis of the minus 200 mesh (0.074) fraction using a Chittick apparatus, Ontario Geoscience Laboratories. Results are summarized in (Morris 2001, Appendix C).

Grain Size

Grain size of samples collected in 1990 and 1991 was determined through the sieve and hydrometer methods. Samples collected in 1996 were initially disaggregated then processed through a MICROTRAC Particle Size Analyzer (Series 9200). This equipment measures the amount and direction of light from a laser beam projected through a stream of particles. The light is measured by an optical detector array and then analyzed by a microcomputer that calculates the size distribution of the particles in the sample stream. This instrument can determine particle size between 0.12 to 704 microns. Grain size of material between 704 and 2000 microns was determined through sieving. Results are summarized in Morris (2001, Appendix D).

Heavy Minerals

Bulk till "C" horizon samples collected in 1994 and 1996 were processed for kimberlite indicator minerals and gold grains. Only the 1996 bulk till "C" horizon samples were processed for metamorphosed and/ or magmatic sulphide indicator minerals. Four bulk "C" horizon samples were collected in 1991 and analyzed for gold grain content. KIM data derived from modern alluvium samples collected in 1994 and 1996 are reported in Morris et al. (1994) and Morris et al. (1997). Gold grain data derived from modern alluvium samples in 1994 are reported in Morris et al. (1994). All other heavy mineral data are reported in Morris (1999a).

Heavy minerals (greater than 3.2 specific gravity) were isolated from modern alluvium and till samples prior to further processing by a contractor. Sample processing data, including weight of table feed and weight of both the non-magnetic and magnetic fractions and heavy mineral picking notes, as reported by the contractor, are summarized in Morris (1999b).

The lab procedure recovers 6 types of KIMs: 1) Cr-pyrope garnet; 2) Cr-poor megacrystic pyrope garnet; 3) eclogitic pyrope-almandine garnet; 4) Cr-diopside; 5) Mg-rich ilmenite; and 6) chromite. Forsteritic olivine, a mineral commonly associated with kimberlite, was also picked when observed in the heavy mineral concentrate. The composition of KIMs recovered from the lab and analyzed on a microprobe is summarized in Morris (1999b). The operation procedure for the microprobe is summarized in GEO LABS (2000).

Thirteen metamorphic or magmatic massive sulphide indicator minerals (MMSIMs®) were also recovered. These included: 1) anthophyllite; 2) chalcopyrite; 3) chromite; 4) Cr-diopside; 5) gahnite; 6) hypersthene; 7) olivine; 8) ruby corundum; 9) red epidote; 10) red rutile; 11) sapphirine; 12) spessartine; and 13) gahnite. Gahnite was the only MMSIM® for which grain composition was determined (Morris 1999b).

A detailed gold grain summary is provided in Morris (1999b) for gold grains recovered from till samples collected in 1991, 1994 and 1996 and modern alluvium samples collected in 1996. Heavy mineral summaries are presented in Morris et al. (1994), Morris et al. (1997) and Morris et al. (1998).

Pebble Lithology

Pebble lithology was determined by comparing the physical and lithological properties of pebbles to representative samples of local bedrock. Identified pebble lithologies included: a) granite; b) quartz; c) mafic metavolcanics; d) felsic metavolcanics; e) ultramafic phaneritic; f) carbonate; g) metasedimentary; h) schist; and i) gneiss. In areas of bedrock consisting of the Doré conglomerate, pebble identification is difficult as the rock is comprised of a variety of lithologies. Both modern alluvium and subglacial till sample pebble data are summarized in Morris (1999b). All other pebble data are summarized in Morris (2001, Appendix E).

QUATERNARY GEOLOGY

Introduction

The Quaternary geology of the Wawa area is relatively uncomplicated; all deposits are of Late Wisconsinan and Recent age. The oldest material encountered is a till that drapes the bedrock surface in many areas. This till has a sand-rich matrix and was deposited from an ice sheet that flowed southwest over the region during the last glacial advance.

Following deposition of this till, glaciofluvial outwash and fine-to coarse-grained glaciolacustrine materials were deposited as the ice margin retreated north and northeast. Glaciolacustrine materials were deposited within glacial lakes associated with the Lake Superior basin and where glacial meltwater ponded between the ice front and topographically higher ground. As well, ice-contact stratified drift was deposited as recessional moraines, eskers or as dead ice topography during ice retreat.

Some of the materials deposited from the ice sheet were subsequently reworked into new landforms during the Holocene. A summary of the region's Quaternary deposits and events are listed in Table 1.

Bedrock Surface Erosional Features

Bedrock surface erosional features in the Wawa area include those caused by abrasion of the rock surface directly by ice flow or by subglacial meltwater. Glacial abrasion features include glacial striae, grooves, chattermarks and ice-molded bedrock forms that are preserved on smooth, unweathered bedrock surfaces (Photograph 1). Striae are the most common glacial erosion feature and are found throughout the study area (Maps 2573 and 2574, back pocket). Glacial grooves, chattermarks and ice-molded bedrock are less pervasive. The orientation of glacial abrasion features is summarized in Morris (2001, Appendix F).

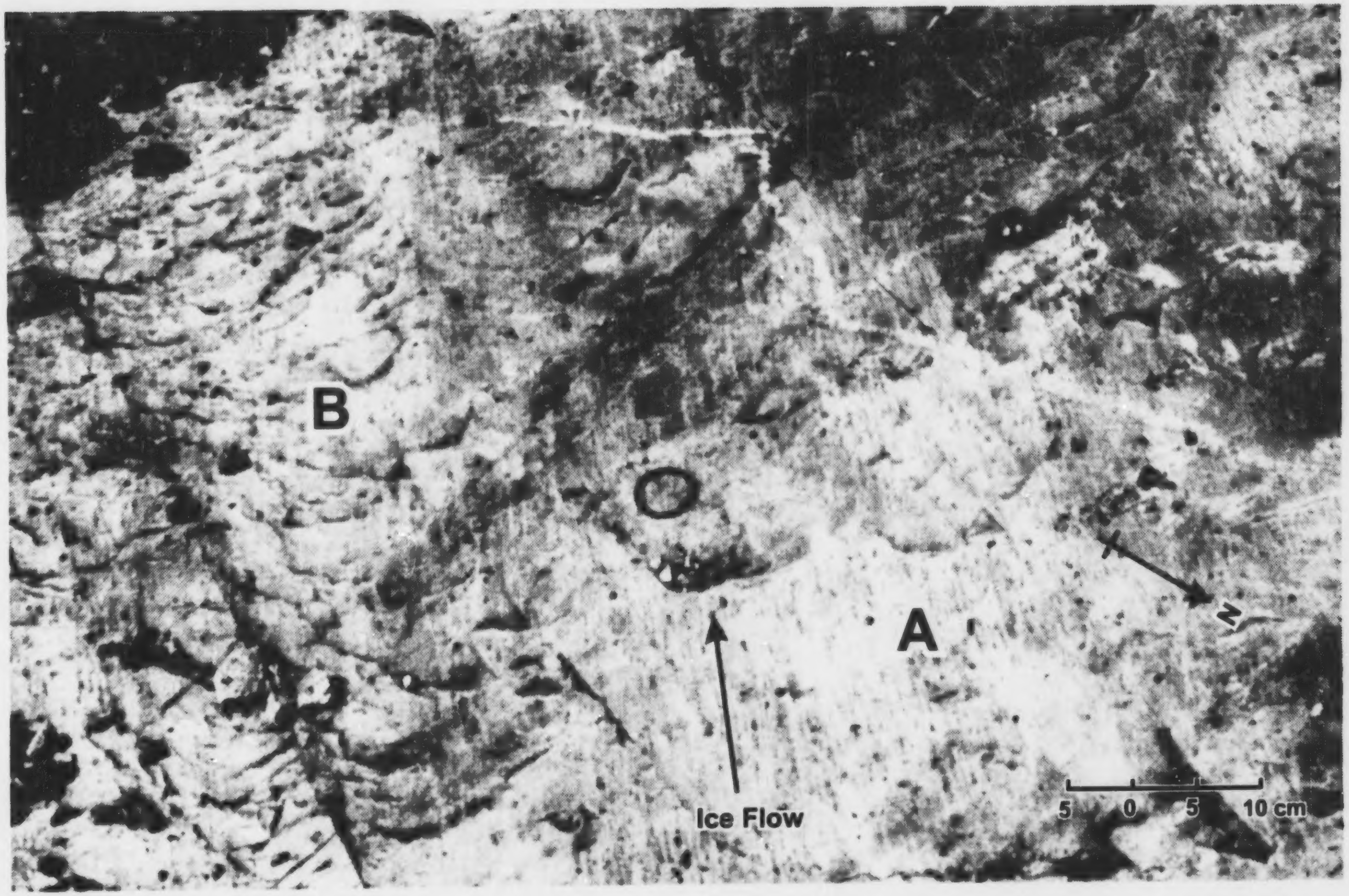
Two sets of glacial striae exist: 1) an older set, oriented between 159° and 240°, that is present throughout the area; and 2) a younger set oriented between 220° and 290°. The younger set of striae is restricted to 2 sites east of the Magpie River valley (Perry Lake area) and one site near the mouth of the Michipicoten River.

The older set of striae are the result of regional glacial flow that was largely unaffected by bedrock topography. Throughout most of the study area the orientation of these ice flow indicators suggests a southwest regional ice flow. To the east (vicinity of McCormick Lake) and west (vicinity of Matchinameigus Lake), however, the regional ice flow tends to be more southerly (200°). The younger set of striae were formed during the latter stages of glaciation as the ice sheet began to thin and bedrock topography began to influence the direction of glacial ice flow.

Bedrock erosion features associated with subglacial meltwater are referred to as "S" forms. In the Wawa area, non-directional form (pothole), transverse form (comma, sichelwannen) and longitudinal form (spindle flute, furrow) were observed (Kor et al. 1991). These features were formed between the base of the ice sheet and the bedrock surface where a narrow bedrock controlled constriction exists. This would suggest limited, localized expulsion of water from the base of the ice.

SURFICIAL SEDIMENT	MATERIAL	LANDFORM	DEPOSITIONAL ENVIRONMENT
Recent			
Man-Emplaced	Mine tailings, waste rock Woodchips	Dam embankments, waste rock and woodchip piles	Human activity
Swamp and Organic	Peat, Muck	Swamps, low-lying areas	Poorly drained bedrock depressions
Modern Lacustrine	Sand and gravel, boulders	Beaches, bars, spits	Shorelines
Modern Alluvium	Medium and fine sand	Longitudinal, transverse, point and diagonal bars, floodplains, ephemeral channel deposits	Channels, floodplanes, minor fans.
Older Alluvium	Reworked medium and fine sand	Sand aprons, meander scars, fluvial bars	Terrace surfaces, areas parallel, but above present rivers.
Eolian	Fine sand	Parabolic dunes, sand sheets	Downwind of glacio-lacustrine or lacustrine deposits
Colluvium	Boulders and coarse, medium and fine sand	Talus aprons and cones	Terrace slopes, bedrock escarpment slopes
Pleistocene			
Glaciolacustrine Topsets	Coarse sand, gravel, boulders	Terrace surfaces	Interface between terrestial and glacio-lacustrine environments
Glaciolacustrine Coarse-grained Deposits	Very fine, fine and medium sand	Terraces, valley fills	Glacial lake deposition, proximal and distal to ice sheet
Glaciolacustrine Fine-grained Deposits	Varved silt and clay	Along shorelines or buried under coarse-grained glaciolacustrine materials	Deep water environments
Glaciofluvial Outwash	Sand and gravel	Outwash plains, fans proximal to former ice sheet	Bedrock controlled valleys or channels
Glaciofluvial Ice-contact Stratified drift	Massive silt and clay, sand, gravel and boulders	Valley fills, recessional moraine, eskers	Ice-proximal, sub-aqueous or subglacial
Till	Sandy to sandy silt with rare clayey-silt lenses	Rolling topography with local dramatic changes in elevation	Subglacial
Bedrock-drift Complex	Thin, discontinuous cover of sandy till, glaciofluvial or peat cover with patches of unmappable till less than 1 m thick	Rolling topography with local dramatic changes in elevation	Subglacial, peat occupies shallow bedrock controlled basins
Bedrock	Bedrock	Rolling topography with local dramatic changes in elevation	

Table 1. Summary of surficial deposits.


B
A
Ice Flow
N
5
0
5
10 cm

Photograph 1. Examples of ice flow indicator features. Striae (A) and chattermarks (B) on a glacially polished bedrock surface, Menzies Township Road.

Drift Thickness

Much of the region's overburden consists of a discontinuous, thin (less than 1 m thick), till veneer that drapes the bedrock surface. Most of the area's thicker surficial deposits are located within bedrock controlled valleys where glaciolacustrine waters from the Lake Superior basin entered the report area. At these locations (Doré, Magpie, Michipicoten and Shikwamkwa river valleys) up to 32 m of glaciolacustrine materials occur.

Away from these river valleys, deposits of till and ice-contact stratified drift (thick enough to mask the underlying bedrock topography) occur as recessional moraine, dead ice topography, valley fill and eskers. Similarly, broad glaciofluvial outwash plains also occur.

Glacial Deposits and Features

Bedrock

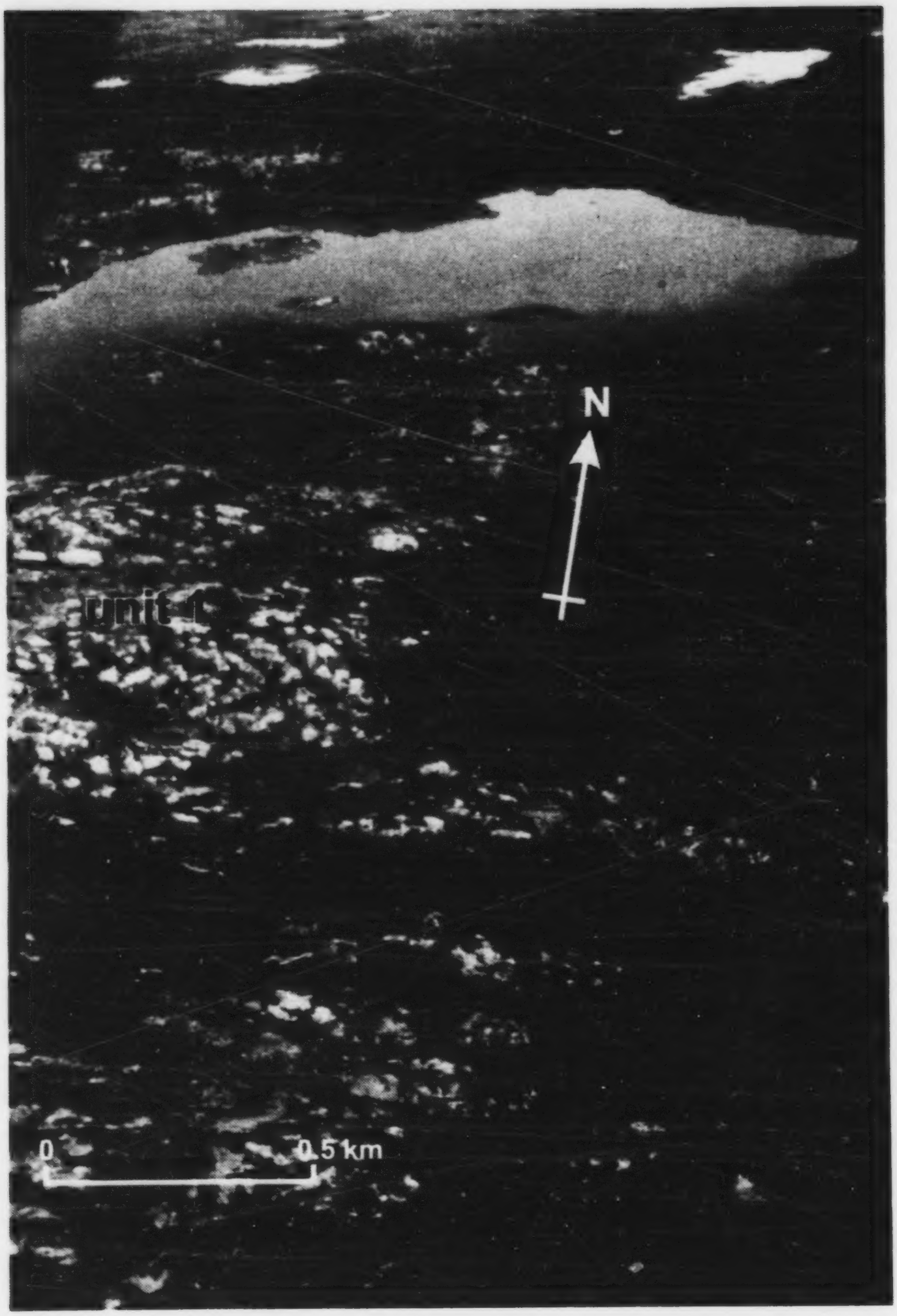
The bedrock map unit (unit 1, Maps 2573 and 2574, back pocket) is defined as an area that consists of more than 50% of exposed bedrock (Photograph 2). A large expanse of this unit occurs parallel to the Magpie River. Localized areas of this unit are found where bedrock ridges occur or where a significant rise in elevation occurs, such as along the shores of Manitowik Lake.

Bedrock-Drift Complex

Where thin, discontinuous overburden covers more than 50% of the bedrock surface the area is mapped as bedrock-drift complex (unit 2, Maps 2573 and 2574, back pocket, Photograph 2). Within this unit overburden is commonly less than 1 m thick. Only rarely, and often on the down-ice side of bedrock highs or where there are fracture infills, does the overburden exceed 1 m in thickness. The types of overburden associated with this unit include till, coarse-grained glaciofluvial material or peat.

Thin Till

Thin, discontinuous till over bedrock is the most common surficial environment in the map area (unit 2a, Maps 2573 and 2574, back pocket). Till is defined as "a sediment that has been transported and subsequently deposited by or from glacial ice, with little or no sorting by water" (Dreimanis 1982). Generally, the soils that develop from this till are classified as Podzols (Clayton et al. 1977). Podzolic soils commonly consist of an organic surface horizon of decomposing forest litter. Underlying this layer, there is commonly an Ah (humus-mineral layer) and an Ae horizon. The "B" horizon underlies the "A" and commonly has a more reddish hue due to accumulation of Fe and Al colloids. Underlying this podzolic "B" horizon is a lighter coloured, unaltered layer of parent material referred



Photograph 2. Bedrock (left of photo) and bedrock-drift complex with thin till cover (right side of photo, darker patches) in the Wawa area. Photo taken east of the Magpie River Valley.

to as the "C" horizon. A detailed description of a section through this unit is presented in Appendix B.

In the Wawa area, the humus is commonly very dark brown (10YR 2/2m) to black (10YR 2/1m) and thin (1-10 cm thick). The humus can be classified as strictly litter (where the structure of the organic material is discernable), fibric (organic matter weakly decomposed) or humic (highly decomposed organic matter). If the humus layer is thick enough, layers of all 3 organic types may be present with the litter at the surface and the humic layer overlying the mineral soil.

The "A" horizon developed on till consists of a pale brown (10YR 6/3 m) to light brownish grey (10YR 6/2 m) silt loam (Table 2). Often this horizon is massive, however, on occasion platy structure was observed. The horizon is commonly thin (1-4 cm thick), wavy and laterally discontinuous. The lower contact is primarily abrupt and planar. As is typical for this horizon, all geochemical values are depleted relative to the other horizons as elements are eluviated downward in the soil profile (Table 3).

Horizon	**Number of Samples**	**Average Percentages**			**Texture**
		Clay	**Silt**	**Sand**	
Thin Till					
"A" Horizon	13	3.12	70.35	26.54	Silt Loam
"B" Horizon	58	2.47	53.13	44.4	Silt Loam
"C" Horizon	36	0.13	20.98	78.89	Loamy Sand
Till					
"B" Horizon	20	3.00	52.28	44.68	Silt Loam
"C" Horizon	16	1.47	27.56	70.97	Loamy Sand

Table 2. Summary of textural data for till derived soil horizons.

Horizon	**Element**
A	
B	Al, As, Au, Be, Br, Cd, Co, Cr, Fe, Hg, Mo, Ni, Pb, Rb, Ta, U, V, W
C	Ag, Ba, Be, Bi, Ca, Ce, Cs, Cu, Eu, Hf, K, La, Lu, Mg, Mn, Na, Nd, Sc, Se,
	Sm, Sr, Tb, Th, Ti, Tl, U, Yb, Zn

Table 3. List of elements with the highest mean geochemical value for thin till over bedrock by soil horizon. This table was generated from geochemical data derived from thin till samples collected within the areas of bedrock-drift complex. Data are presented in Morris (1999b) and Morris (2001).

The till soil "B" horizon consists of a dark yellowish brown (10YR 4/4 m) to reddish brown (5YR 4/3 m) silt loam (Table 2). The horizon was often structureless, however, thin (mm thick), platy bedding was sometimes observed. Based on the mean values of each element this horizon is enriched in iron and aluminum relative to the other soil horizons, as is typically the case for Podzolic "B" horizons (Table 3). A number of other elements have higher mean values than are found within the underlying "C" horizon materials, however, this may be related to local sampling conditions rather than to pedogenic process (i.e. where only a "B" horizon sample could be collected over mineralization). The lower contact of the "B" horizon is often diffuse (greater than 15 cm) to gradational (2 to 15 cm) and wavy to irregular.

The "C" horizon consists of brown (10YR 4/4 m) to yellowish brown (10YR 5/6 m) loamy sand (Table 2). This material is often fissile, caused by shearing associated with the till lodgment process. Occasionally, flow structure caused by sub-glacial flow into lee cavity pockets was observed. Geochemically, most of the elements tended to have higher concentrations in the "C" rather than the other 2 horizons (Table 3). Anomalous geochemical values (greater than the 95th percentile) are closely related to local mineralization. There is little to no dispersal of the geochemical signature in "C" horizon material away from mineralization (Morris 1999a).

Carbonate data for samples of "A" and "B" horizons are summarized in Table 4, and in Morris (2001, Appendix C). In the field the material often does not react with 10% HCl. When it does, the sample site is commonly associated with known iron deposits where ankarite, an iron carbonate, exists.

Material	Number of Samples	%Calcium	%Dolomite	Total	Ratio
Thin Till					
"A" Horizon	6	0.55	1.05	1.45	0.52
"B" Horizon	39	0.56	0.81	1.37	0.84
Till					
"B" Horizon	15	0.55	0.77	1.31	0.75
"C" Horizon	3	0.55	0.77	1.31	0.75

Table 4. Summary of average carbonate values for till derived soil horizons.

Pebble lithology data for thin till over bedrock are summarized and discussed in Morris (1999a, 1999b, 2001, Appendix E). Generally, the percentage of felsic intrusive pebbles is relatively high regardless of the bedrock terrane over which the material was sampled. This reflects the relatively small size of the lithological units associated with the Michipicoten greenstone belt as compared to the surrounding felsic intrusive terrane.

Nonetheless, there is an association between bedrock lithologies or terranes and the percentage of corresponding pebbles found in samples collected over that bedrock type. For example, the average percentage of mafic metavolcanic pebbles collected from thin till samples collected over mafic metavolcanic terrane is 41%, while the average percentage of felsic intrusive pebbles is 40%. Over felsic intrusive terrane, the average percentage of felsic intrusive pebbles increases to 75%, while the average percentage of mafic metavolcanic pebbles drops to 21%.

Pebbles from thin till samples were sometimes striated and angular. Only one fabric analysis was completed within the bedrock-drift complex and results compared well (226°; Table 5; Morris 2001, Appendix H) with the local glacial striae orientation.

Measured Site	U.T.M.		Number of Measurements	Azimuth (Degrees)	Resultant "R" Vector	Comment
	Easting	Northing				
Thin till (< 1 m)						
13-90	673100	5322000	15	225.6	93.70%	The distribution has a preferred trend
Till Fabric (> 1 m)						
70-90	680050	5328800	50	147.7	89.5 %	The distribution has a preferred trend
409-90	657600	5321700	50	353.5	25.4 %	The distribution has a preferred trend
423-90	653900	5323950	50	132.3	4.4 %	The distribution is statistically uniform
429-90	652700	5323400	50	22.1	18.2 %	The distribution is statistically uniform

Table 5. Summary of till fabric measurements. The resultant or "R" value is based on the Fisher analysis used for analyzing vector data. The maximum direction is calculated as the resultant, or vector sum, of all the direction vectors. The most ideal "R" value is 95% or greater, indicating that most vectors cluster within a 95% confidence cone.

Coarse-grained Glaciofluvial Material

Bedrock-drift complex with a thin mantle of coarse-grained glaciofluvial material is a relatively minor unit in the map area and was observed only west of the Steephill Falls Dam on the Magpie River (unit 2b, Map 2574, back pocket). Thin amounts of coarse sand and gravel with boulders of local lithology was observed on topographically high ground within shallow, elongated depressions on the bedrock surface.

Peat

Several organic depressions in the northwestern part of the study area were probed and bedrock was encountered at less than 1 m depth (unit 2c, Map 2574, back pocket). The organic filled depressions associated with bedrock-drift complex are often broad, shallow and rimmed by bedrock. Ephemeral channels are often located around the perimeter and extend away from these basins. These channels likely drain water from the depression in early spring, after snow melt or after intense summer rainfall.

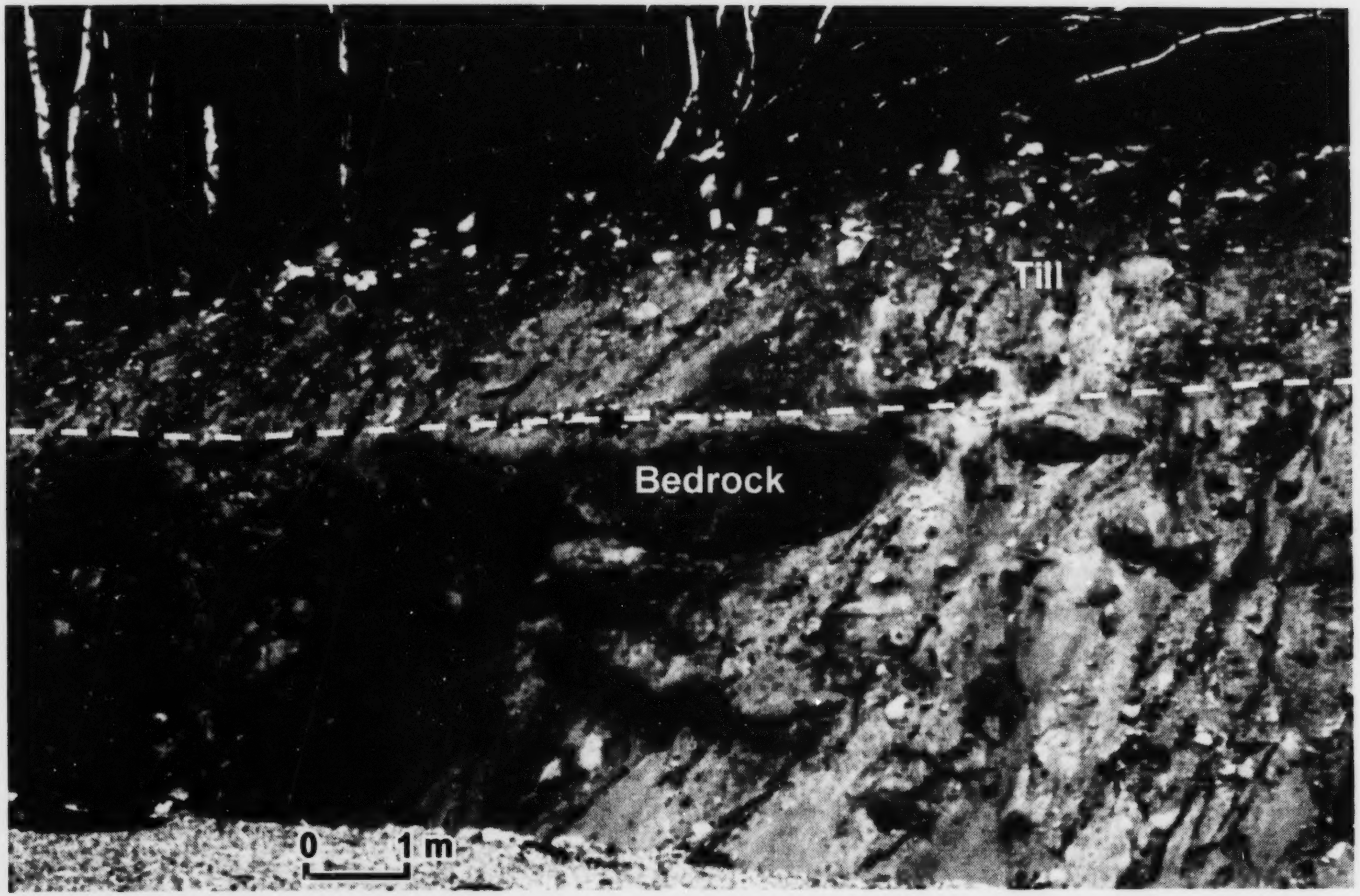
Till

Till within the report area was deposited during ice recession and is commonly thicker (>1 m) than the till associated with the bedrock-drift complex. The thicker till is often associated with recessional moraines, as isolated patches located at the headwaters of outwash systems or around the periphery of former glacial lake basins (unit 3, Maps 2573 and 2574, back pocket). The moraines tend to be of low relief (a meter to a few meters in height, Photograph 3) and composed largely of flow tills that may be interbedded with better-sorted materials. Moraine orientations indicate a northward and northeastward retreat of the ice margin in the western and eastern parts respectively, of the map area. Bedrock outcrops were rarely observed within areas of thicker till cover.

The thicker till consists of material derived from the subglacial (base), englacial (middle) or supraglacial (surface) positions of the glacier. Although a component of this till may be deposited by the lodgment process (comprised primarily of local materials), much of this thicker till is deposited as "flows" (comprised of a wider variability of local and distally derived materials). Flow tills within the report area do not have strong fabric (Table 5; Morris 2001, Appendix H). Soils that develop on these thicker tills are classified as podzolic, consisting of humus, "A", "B" and "C" horizons. A detailed description of a section through this thicker till, associated with a recessional moraine, is presented in Appendix B.

Humus overlying thicker till exhibits the same colour (very dark brown to black), thickness (1-10 cm) and classification (litter, fibric and humic) as does humus associated with thin till in the bedrock-drift complex. The "A" horizon of the thicker till has similar colour (pale brown to light brownish grey), structure (massive or platy), thickness (1- 4 cm) and form (wavy and laterally discontinuous) to thin till that forms a veneer over bedrock.

Till "B" horizon has similar colour (dark yellowish brown-to reddish brown), texture (silt loam, Table 2) and enrichment in iron relative to the "C" horizon as noted in thin till deposits of the bedrock-drift complex. The lower contact of the "B" horizon is typically diffuse (greater than 15 cm) and wavy.



Photograph 3. Till exposure on a minor recessional moraine south of Dubreuilville on the Magino Mine road. Within the section approximately 1.5-2 m of flow till overlies mafic metavolcanic rock.

The till "C" horizon is brown (10YR 4/4 m) to yellowish brown (10YR 5/6 m) loamy sand (Table 2). Often the unit exhibits flow structure caused by release of material proximal to the ice sheet. A summary of the mean geochemical values for elements within the till "B" and "C" horizons is presented in Table 6.

Soil Horizon	"B"	"B"	"C"	"C"
Study Year	1990	1991	1990	1991
No. of Samples	15	21	3	1

Element				
Ag (ppm)	1.13	0.25	1	0.25
As (ppm)	5.94	3.24	2.6	0.5
Au (ppb)	3.4	2.5	4.67	2.5
Co (ppm)	13.67	8.19	22	11
Cr (ppm)	78.33	78.33	73.33	38
Cu (ppm)	29	20.76	61	69
Fe (ppm)	3.33	N.D.	2.5	N.D.
Mo (ppm)	N.D.	0.6	N.D.	0.5
Ni (ppm)	31.4	30.52	43.33	20
Pb (ppm)	14.2	6.24	8.33	22
Sb (ppm)	N.D.	0.11	N.D.	0.1
Th (ppm)	N.D.	5.48	N.D.	15
U (ppm)	N.D.	1.64	N.D.	2.4
Zn (ppm)	56.33	38	57.33	42

Table 6. Summary of mean geochemical values for elements by horizon for thick (> 1 m) till deposits.

Till matrix carbonate content for the till "B" and "C" horizons is low (Table 4). The percentage of calcite and dolomite are fairly similar indicating that there is no preference of one mineral type over another. The slightly higher total carbonate values in the till "C" horizon may indicate incorporation of carbonate from local ankerite sources or that the material has not been leached.

The pebble component of this till can be highly variable: the carbonate pebble content can reach as high as 9%. The carbonate pebbles are derived from the Hudson and James Bay lowlands. Many of these pebbles are exquisitely preserved fossils. The percentage of mafic and felsic metavolcanic pebbles associated with this thicker till collected over mafic and felsic metavolcanic terranes can vary from as low as 0% to as high as 93% (Morris 2001, Appendix E).

Ice-Contact Stratified Drift

Ice-contact stratified drift is associated with 3 types of deposits: 1) eskers; b) recessional moraines; and 3) dead-ice topography (unit 4, Maps 2573 and 2574, back pocket). The larger eskers (2 km long) are confined to bedrock controlled valleys or basins where subglacial meltwater was concentrated. Esker height is difficult to determine as many esker flanks are buried by glaciofluvial or glaciolacustrine deposits. Sections through the eskers are rare, although, it is evident that they consist of sand, gravel and coarse boulders. The boulder facies tends to be massive and poorly sorted.

Moraines associated with ice-contact stratified drift can be laterally extensive (over 1 km in length). Moraine orientation and distribution indicate ice margin recession to the north and northeast in the western and eastern parts of the map area respectively. Unlike moraines composed of till, these moraines tend to be higher and composed of stratified materials. A detailed description of a section through ice-contact stratified drift, associated with a recessional moraine, is presented in Appendix B. The actual height of these moraines, like the eskers, is difficult to determine as the flanks of the moraines are often buried, or partially buried, by glaciofluvial or glaciolacustrine materials.

Dead ice topography is caused by the *in-situ* melting of blocks of glacial ice that have become detached from the active ice sheet and melt in place. The melting of this glacial ice leaves a topography consisting of steep sided conical hills (kames) and deep circular to ellipsoid depressions (kettles). In the report area, this type of topography is commonly located around the periphery of small bedrock depressions occupied by lakes or along the banks of stream segments. Like the recessional moraines and eskers, this type of landform consists of stratified materials.

Glaciofluvial Outwash

Texturally, glaciofluvial outwash deposits consist primarily of sand (Morris 2001, Appendix D). The texture of the material varies, however, depending on the proximity to the ice margin or location relative to the main channel flow. Distal to the ice margin, sand was deposited in planar beds with paleocurrent measurements generally aligned parallel to meltwater channel orientation (Morris 2001, Appendix H). Proximal to the ice margin, sand beds are massive. Gravel and boulder beds tend to be massive planar units. Clast imbrication, where observed, indicates flow parallel to the orientation of meltwater channels. Outwash thickness is variable and is controlled by bedrock topography. Within channels outwash thicknesses ranges from less than 1 m to over 17 m within bedrock basins. A detailed description of a section through outwash is presented in Appendix B.

In the western part of the study area, outwash is generally restricted to 8 meltwater channels presently occupied by the Doré and Magpie rivers, Firesand and McVeigh creeks or basins now occupied by the Molybdenite, Catfish, Hawk and Grant lakes (unit 5, Maps 2573 and 2574, back pocket). Outwash within these meltwater channels consists of sand with minor amounts of gravel. A coarse, bouldery gravel is present in the uppermost 2 terraces within the Magpie River valley below Steephills Falls. This gravel represents the upper 1 to 3 m of these terraces and has a sharp, erosional lower contact.

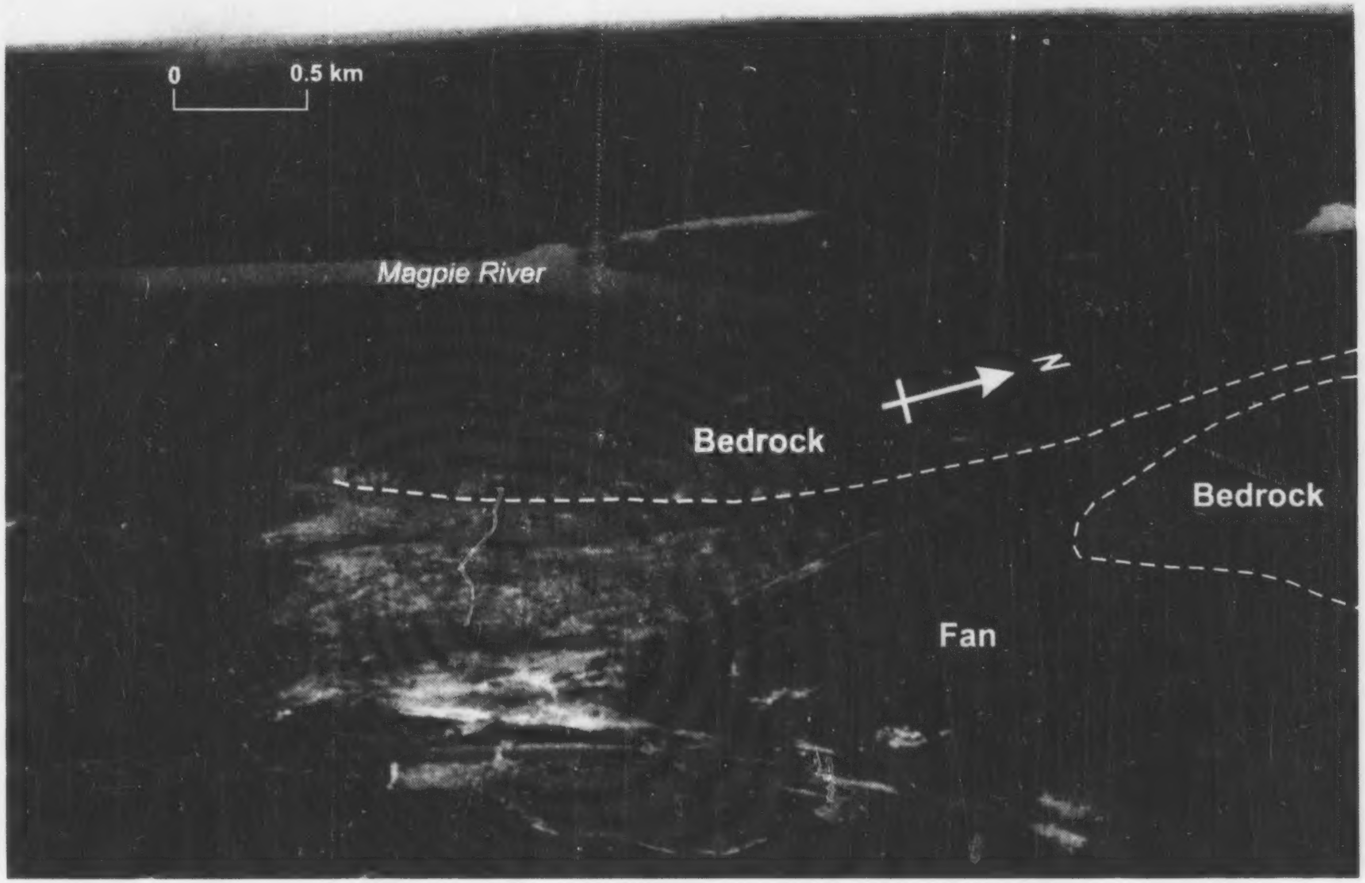
In the eastern part of the study area outwash is restricted to narrow meltwater channels that either extend from former ice margins or exit from ice-contact lakes. A broad northeast trending belt of outwash exists between Goudreau and Localsh. In the eastern part of the map area, many meltwater channels and related outwash deposits occur at high elevations (unit 4, Map 2573, back pocket). Ice blocking lower valleys forced water to flow through these higher channels. As the ice margin retreated, lower channels were exposed and meltwater was diverted through these channels. The pattern of ice retreat for the region was determined, in part, by defining the distribution of the topographically higher meltwater channels. Meltwater channels within the western part of the map area (unit 4, Map 2574, back pocket) extend down-drainage from well-defined ice margins.

East of the Magpie River, 2 separate meltwater channels, each constrained by bedrock valley walls, extend southeastward from former ice margins. These meltwater channels expand onto separate broad outwash plains. On each of these a spectacular outwash fan was deposited (Photograph 4, unit 4, Map 2574, back pocket). The apex of these fans consist of coarse sand and boulders which fines distally to sand towards the fan's periphery.

Smaller fans exist at the terminus of local highland channels. In many cases, the fan apex is associated with ice marginal positions during retreat. In other cases, tongues of ice extending through local valleys or lake basins issued meltwater through lateral southward trending openings in the constraining bedrock walls (unit 4, Maps 2573 and 2574, back pocket).

Elsewhere, the orientation of small fans located at the terminus of highland channels indicate meltwater flow to the north. In these areas, glacial meltwater issuing from detached blocks of wasting ice, left stranded in highland areas, flowed north into adjacent valleys. An example of this occurs at Mink Lake (north of Wawa) where kames and kettles exist around the lake basin. Extending north from the lake basin is a fan indicating flow of meltwater north, away from the basin (unit 4, Map 2574, back pocket).

In some cases, narrow meltwater scour features occur within former channel constrictions. These features are elongated depressions carved into the bedrock floor or overburden surface by meltwater forced to flow through a constriction at the base of the ice. At the distal end of one such scour, abundant, rounded to sub-rounded boulders were observed. Many of these scours are presently filled with water.


0
0.5 km
Magpie River
N
Bedrock
Bedrock
Fan

Photograph 4. Spectacular glaciofluvial outwash fan located east of the Magpie River valley (background). The outer margin of the fan extends to Jubilee Creek.

Glaciolacustrine (Fine-grained) Deep Water Deposits

Fine-grained, deep water sediments consist of horizontally bedded couplets of varved silt and clay (Photograph 5). In some sections, horizontal bedding was disturbed by escaping water as evidenced by forms such as munroes or flame structures.

Unweathered exposures reveal silt layers that are dark grey (10 YR 4/1 m), usually 3 to 4.5 cm thick, and clay layers that are light grey (10 YR 7/1 m), usually 0.5 to 2 cm thick. When weathered, the silt layers are grey (10 YR 5/1 m) and the clay layers are a reddish brown (5 YR 5/3 m). Bulk grain size analysis indicates that this material is predominantly silt (94%) with minor clay (5%) (Morris 2001, Appendix D).

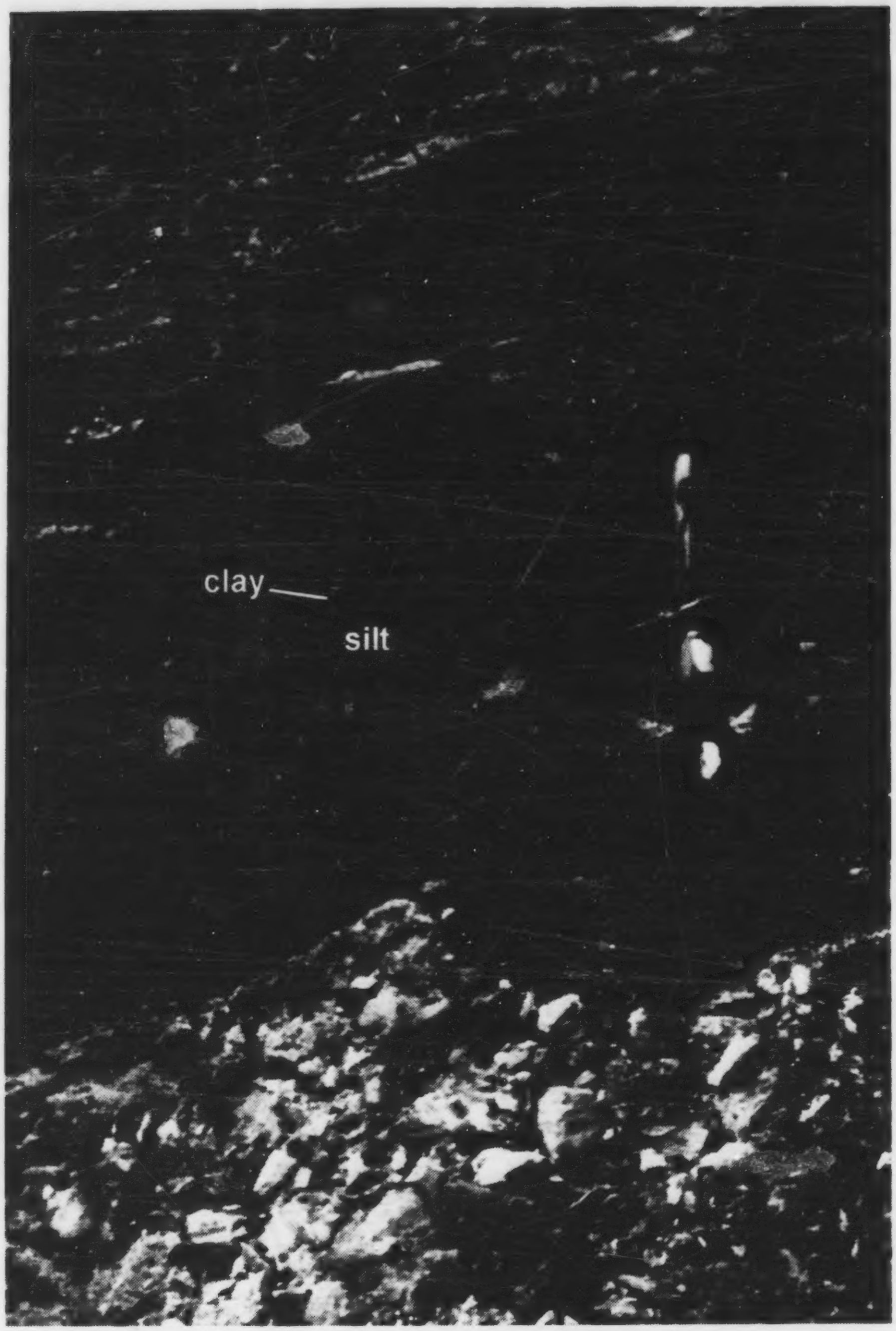
Glaciolacustrine fine-grained deposits are exposed along the shores of Dingman Bay and 2 unnamed bays along the northwest and southeast shore of Manitowik Lake. Varved silts and clay were also observed along the south shore of Localsh Bay, however, these are buried under a thin layer of sand derived from coarse-grained glaciolacustrine material (unit 6, Map 2573, back pocket). Varved silt and clay were also observed along the east side of the Magpie River Valley and in drill cuttings during construction of Steephills Fall Dam on the Magpie River.

Within the Magpie River valley 25 silt and clay couplets, each measuring about 5 cm in thickness, underlie deltaic sands and drape the bedrock surface. Drilling south of the Steephills Fall Dam (ACRES drill hole logs, 1974) indicates that 3.74 m of silt with light grey partings lies beneath sand and gravel. The hole did not extend to bedrock. Assuming an average couplet thickness of 5 cm this represents a minimum of 75 couplets.

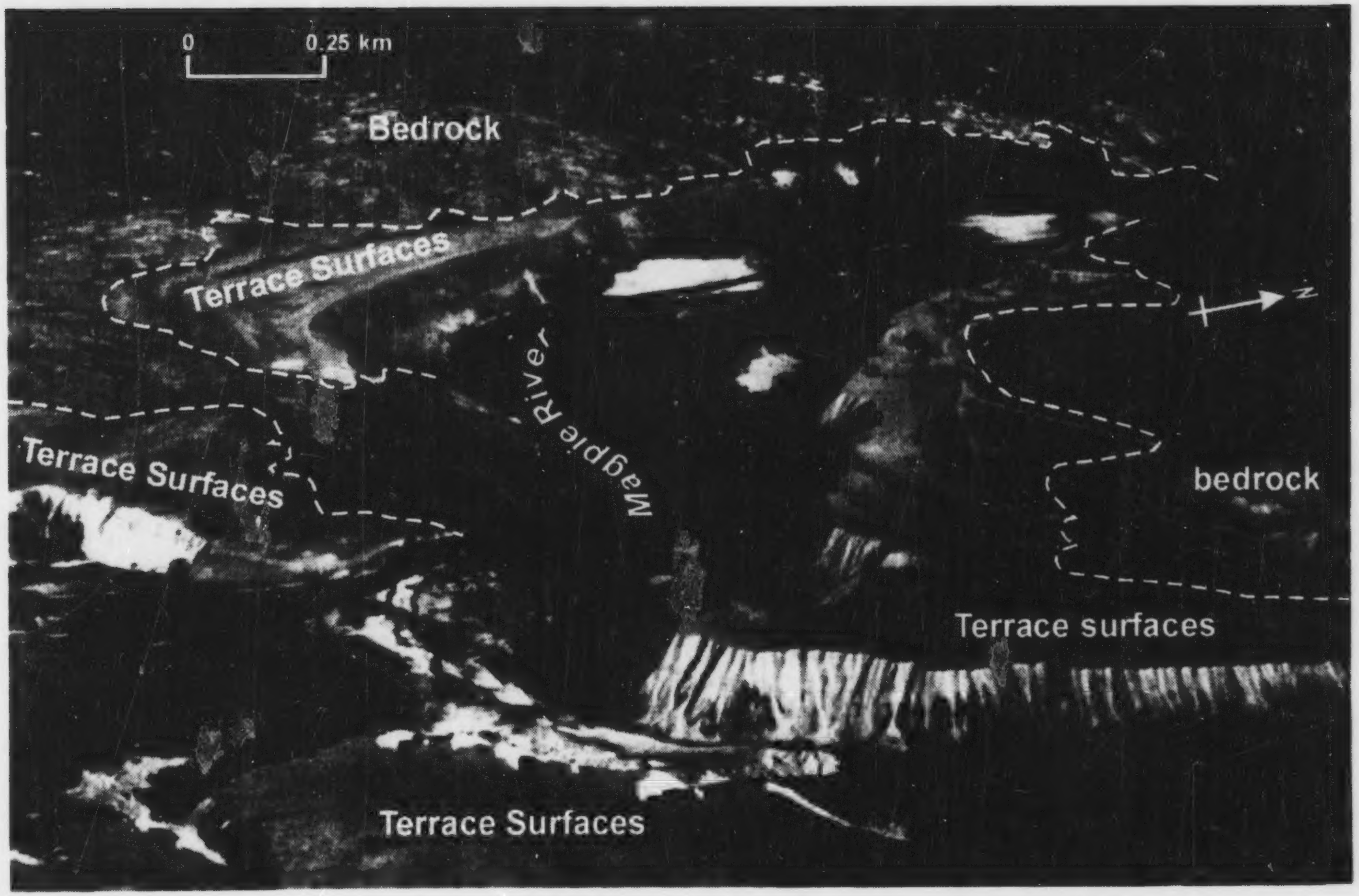
Glaciolacustrine (Coarse-grained) Deposits

Coarse-grained glaciolacustrine deposits consist of a light brownish grey (10 YR 6/2 m) to brown (10 YR 5/3 m) sand. Material texture ranges from coarse to silty sand depending on where the sample was obtained within the deposit (Morris 2001, Appendix D). This material forms deltas that mark former high lake levels within the Lake Superior basin as well as less stable glacial lakes temporarily impounded between the ice sheet and bedrock highlands (unit 7, Maps 2573 and 2574, back pocket). A detailed description of a section through a this material is presented in Appendix B.

Coarse-grained glaciolacustrine sediments have been observed in the lower reaches of the Magpie, Michipicoten and Doré river valleys, at the railway sidings in Dalton and Localsh, and around the Fletcher, Dog, Manitowik and Dingman lake areas. In the Magpie and Michipicoten river valleys, successively lower stages of river flow have incised through deltaic sediments to bedrock, leaving a series of spectacular river terraces (Photograph 6). The surface of the highest river terrace is 33 m above the present



Photograph 5. Glaciolacustrine varved silt and clay deposit at the base of a terrace, Magpie River Valley.


0
0.25 km
Bedrock
Terrace Surfaces
Magpie River
N
Terrace Surfaces
bedrock
Terrace surfaces
Terrace Surfaces

Photograph 6. Terraces of the Magpie River valley grade to glacial lake levels within the Lake Superior basin.

river level. All terrace surfaces were measured with a Wallace and Tiernan altimeter. These results are summarized in Morris (2001, Appendix I).

Excellent exposures through several terraces reveal faintly bedded sand that fines upward, gently dipping cross beds, trough cross beds and climbing ripples. In general, material tends to coarsen upwards through the sequence from silt at the base to medium- to coarse-grained planar beds at the surface. The faint, fining upward horizontal planar beds are interpreted to have been deposited by density underflow currents. The gently dipping planar beds are interpreted as either low angle foreset or bottom-set beds.

Glaciolacustrine Topset Deposits

Capping the glaciolacustrine deposits within the lower and upper reaches of the Magpie River valley is a layer of bouldery sand (unit 8, Map 2574, back pocket). Most of this unit consists of clast supported boulders with a sand matrix that varies in thickness between 0.5 to 3 m. The lower contact is sharp and clear. Most of the colluvium that covers the terrace slopes in the lower reaches of the Magpie River valley is derived from this unit.

Recent Deposits

Colluvium

Significant colluvial deposits occur where rivers have cut through thick deposits of glaciolacustrine sand. Examples of colluvial deposits are found within the Magpie, Michipicoten and Jackpine rivers and the Goldie and Ogisiwi creeks near Dalton (unit 9, Maps 2573 and 2574, back pocket). Colluvium associated with these deposits consists of light brown (7.5 YR 6/4 m) to brown (10 YR 5/3 m) coarse sand and boulders.

Significant colluvial deposits cover the terrace slopes of the Magpie River valley. Less extensive colluvial deposits occur along the base of steep bedrock escarpments. In these areas, the colluvium consists of larger boulders measuring several meters across.

Eolian

Eolian deposits consist of yellow (5 Y 7/6 m) fine- to medium-grained sand (Morris 2001, Appendix D). Internal, depositional structures were not observed as sections through eolian deposits were poor or non-existent. Significant deposits of eolian sand occur in an area between Goudreau and Localsh. Eolian forms include parabolic and longitudinal dunes, however, the area covered by these features is restricted. Only 4 dunes are associated with the largest deposit. Most other dunes occur as single features, ranging in height from 9.0 to 16.1 m.

Dunes are preferentially located on the leeward side of former glacial lakes and occasionally within the broad outwash plain southeast of Goudreau (unit 10, Map 2573, back pocket). Dune orientation indicates a prevailing wind from the northwest.

A thin, discontinuous cover of eolian sand occurs within the Magpie River valley. This material is derived by the winnowing of sand from glaciofluvial and glaciolacustrine materials.

Older Alluvium

Older alluvium consists of pale brown (10 YR 6/3 m) fine- to coarse-grained sand. Older alluvium is restricted to the Magpie River valley below Steephills Fall dam, the Michipicoten River valley below High Falls dam, the Doré River and smaller rivers and creeks west and east of the Doré River (unit 11, Map 2574, back pocket). Older alluvial deposits consist of material derived from the erosion of glaciolacustrine deposits that formed within these valleys. A single exposure within a bar in the Magpie River valley revealed planar bedded sand dipping in the down-stream direction. The angle of the bedding mimics the slope of the underlying bedrock. The internal structure of each planar bed consists of a fining upward sequence of parallel laminated sand to climbing ripples which in turn are capped by a thin layer of silt. The silt cap over each unit suggests that water flow was reduced periodically. This may have been daily, seasonal or may have been controlled by periods of drought through summer months. Fifty-seven couplets were counted.

Modern Alluvium

Modern alluvium consists primarily of sand and minor quantities of organic rich sand and gravel. Modern alluvium is generally associated with those streams and rivers flowing over glaciofluvial or glaciolacustrine deposits, where there is a readily available supply of material (unit 12, Maps 2573 and 2574, back pocket). The texture of the modern alluvium is controlled by the texture of the overburden material from which it has been derived. The pebble lithology of the modern alluvium deposit is also controlled by the pebble lithology of the parent overburden material as well as the local bedrock terrane. Pebble lithology of modern alluvium is summarized and discussed elsewhere in Morris (1999a).

Modern Lacustrine

Modern lacustrine deposits are associated with post-glacial and modern lakes. The material comprising these deposits and landforms is largely derived from glaciofluvial and glaciolacustrine deposits. As such, the colour and texture of these deposits are highly variable. Common modern lacustrine deposits include beaches, barrier bars, tombolos and spits (unit 13, Maps 2573 and 2574, back pocket).

Swamp and Organic Deposits

Swamp and organic deposits occur in poorly drained areas. These deposits occur in bedrock controlled depressions at any elevation, within kettles, between eskers, within floodplains, beside meandering rivers or streams or within the basin of former meltwater channels (unit 14, Maps 2573 and 2574, back pocket).

Deposits develop from the accumulation of decaying mosses, rushes and woody materials. Commonly, at surface, the deposit consists of fibrous organic materials that can be easily identified. With depth, fibrous materials grade to mesic and eventually to humic materials. Most of the swamp and organic deposits probed in the study area were 1 to 1.5 m thick.

Man-emplaced Deposits

Man-emplaced deposits include waste rock and tailing ponds from mine workings and waste from lumber mills. Waste rock from mine workings occur: at Sinterville on the northwest edge of Wawa; the former Helen Mine north of Wawa Lake; the Sir James Dunn Mine, south of Lena Lake; the Lucy Mine east of Mildred Lake; and the Bear Range and "A" Iron range east of Goudreau. Mine tailing ponds occur north of Sinterville and at the Magino and Canamax mines east of Goudreau (unit 15, Map 2574, back pocket). Waste from lumber mills occur at Missanabie and the railway siding at Dalton (unit 15, Map 2573, back pocket).

Glacial and Post-Glacial History

Regional Ice Flow

The earliest recorded ice flow in the region was likely of Late Wisconsinan age (about 80 ka) and is related to ice associated with the Laurentide Ice Sheet. Glacial flow was to the southwest and was largely unaffected by bedrock topography (Figure 3). Evidence of this early ice flow includes the presence of subglacial till and the erosional molding of the bedrock surface through abrasion and plucking of the rock surface by glacial ice flow. As the ice sheet thinned during the latter stages of this regional flow, bedrock topography controlled ice flow (Figure 3). Subglacial meltwater from the thinning ice carved "S" forms into the bedrock surface.

Deglacial and Post-glacial History

As the margin of the Laurentide Ice Sheet retreated from the study area, several types of material and landforms were deposited. The orientation, distribution and elevation of landforms such as recessional moraine, eskers, glaciofluvial fans and glaciolacustrine terraces provides insight into: a) the direction of ice retreat; and b) the extent of glacial

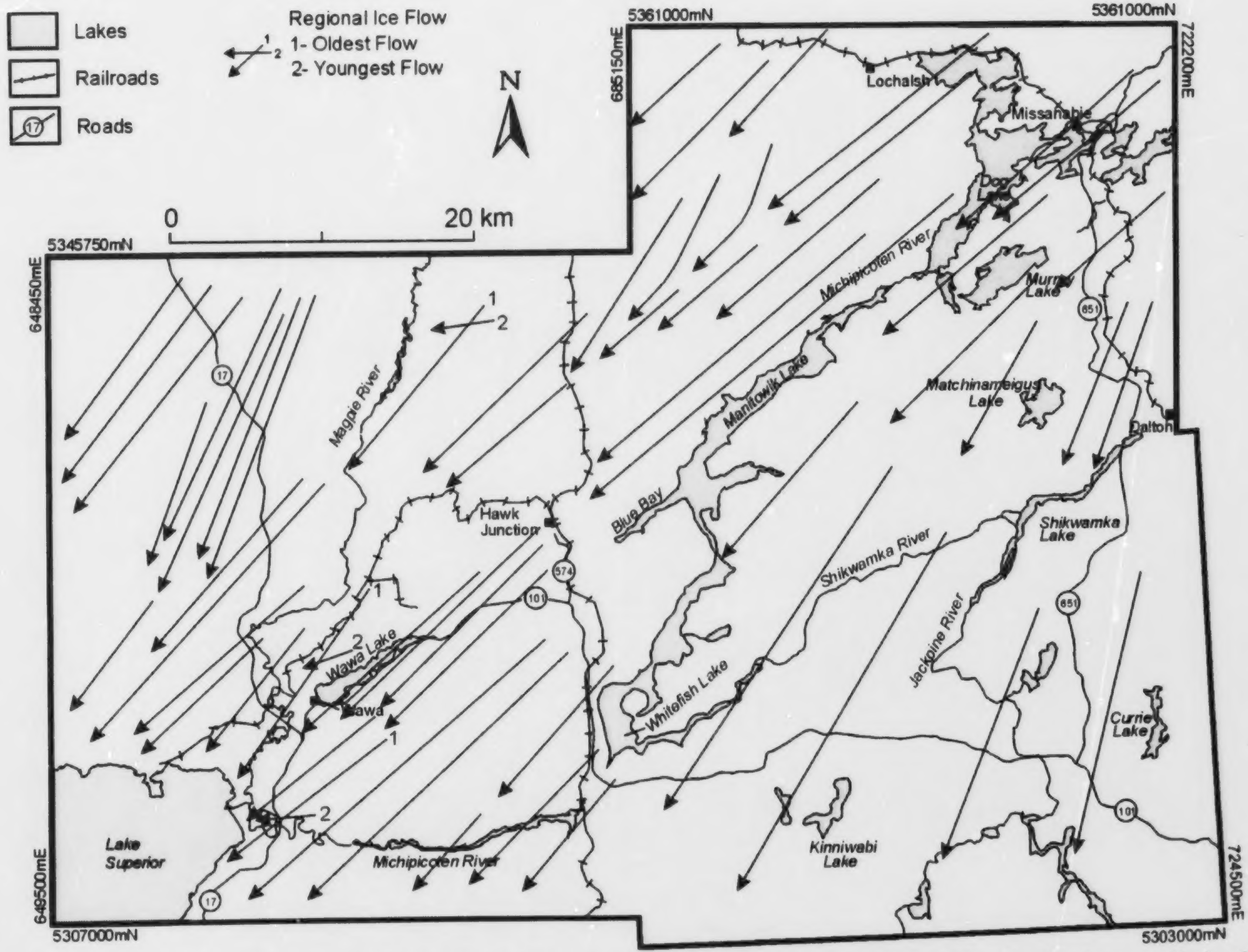

Lakes
Railroads
Roads
17
Regional Ice Flow
1- Oldest Flow
2- Youngest Flow
N
0
20 km
5361000mN
5361000mN
685150mE
722200mE
5345750mN
648450mE
649500mE
5307000mN
5303000mN
724500mE
Lochalsh
Missanabie
Dog Lake
Murray Lake
Michipicoten River
Manitowik Lake
Matchinameigus Lake
Dalton
651
Blue Bay
Hawk Junction
574
101
Magpie River
Wawa Lake
Wawa
1
2
Shikwamka Lake
Shikwamka River
Jackpine River
Whitefish Lake
Currie Lake
Kinniwabi Lake
Lake Superior
Michipicoten River

Figure 3. Regional ice flow over the Wawa area. Locally, during the latter stages of glaciation, bedrock-controlled valleys directed flow in a more westerly direction.

lake waters related to the Superior and local lake basins.

Recessional moraines were deposited by glacial debris flowing off the ice during temporary glacial still-stands. Several segments of recessional moraine, stretching east to west across the study area, relate to the Cartier Moraine as defined by Boissonneau (1968). The distribution and orientation of these moraines indicates that in the western part of the study area the ice front retreated to the north while in the central and eastern parts of the study area ice wasted to the northeast.

"S" forms, potholes and scour channels were carved into bedrock beneath the ice sheet by glacial meltwater flowing under confined pressure. Proximal to the ice margin, glacial meltwater flow was concentrated and directed through several well-defined, bedrock controlled valleys and narrow lake basins. The location of these meltwater channels is defined by the distribution of glaciofluvial outwash deposits within bedrock controlled valleys and glaciofluvial fans that terminate within bedrock controlled lake basins.

Glacial meltwater flowed into glacial lakes associated with either the Lake Superior basin or into local basins where glacial meltwater was confined between the ice margin and higher ground. The glacial and post-glacial lake history associated with the Lake Superior basin includes 7 prominent lake stages that include from oldest to youngest; the Minong, post-Minong (or Dorion), Houghton, Nipissing, Algoma, Sault and sub-Sault (Farrand 1960, Farrand and Drexler 1985).

Minong and post-Minong lake levels in the Superior basin were controlled by an overburden sill that extended from Nedoway Point, Michigan to Gros Cap, Ontario (Saarnisto 1975) near Sault Ste. Marie, Ontario. Within these 2 main stages several substages have been defined. For the Minong, the 3 substages of Minong I, II and III are recorded in the study area by prominent terrace surfaces. For the post-Minong, there are 4 sub-stages; post-Minong I, II, III, IV. All 4 sub-stages of the post-Minong are recorded in the Wawa area by terrace surfaces.

Between these prominent terrace surfaces, representing the established lake level sequences, several minor terrace surfaces exist. These minor terrace surfaces likely represent stable, short-term lake levels in the Superior basin. A similar observation was made in the Sault Ste. Marie area where numerous shorelines were recorded between the main lake phases (Cowan 1985)

The elevations of several terrace surfaces were recorded and are summarized in Morris (2001, Appendix H). As the ice margin retreated from the study area, glacioisotatic adjustment of the earth's surface occurred. As such, the landscape elevation rises to the northeast, towards the former centre of the ice sheet. This isostatic adjustment for the Lake Superior basin (i.e., the rate at which this elevation increases over distance for each of the different lake levels) is summarized in Farrand and Drexler (1985).

For the Wawa area, the rate at which elevation increases over distance for each of the lake levels is summarized Table 7. When the elevation of delta surfaces marking former lake levels are adjusted to accommodate isostatic rebound, it is possible to define the distribution of glacial and post-glacial lake levels within the Wawa region.

Glacial Lake	Elevation at Wawa	Date of Organic Material, Collected in the Wawa Area	Approx. Age of Lake (Years B.P.)	Isostatic Adjustment Over Distance, Wawa Area
Minong I	308.2 m	9750 +/- 170 BP (peat)	9500- 9800	1.14 m/ km
Minong II	298.7 m			1.14 m/ km
Minong III	292.3 m	8820 +/- 80 BP (antler)	9000	1.14 m/ km
Post-Minong I	280.7 m			1.14 m/ km
Post-Minong II	269.4 m			1.14 m/ km
Post-Minong III	260.3 m			1.14 m/ km
Post Minong IV	250.8 m		8000	1.14 m/ km
Houghton	238.0 m		7500	0.51 m/ km
Nipissing	214.0 m		6500	0.39 m/ km
Algoma	205.1 m		3500	0.17 m/ km
Sault	196.9 m		2000	0.08 m/ km
Sub-Sault	189.9 m		1000	0.03 m/ km
Present	184.1 m			

Table 7. Summary of lake levels in the Lake Superior basin, Wawa area.

In addition to the Lake Superior basin, several glacial lakes and associated deposits were defined where glacial meltwater was trapped between the ice margin and higher ground. Larger lakes established in this manner include areas: a) centred over the Jackfish river; b) east of Dillon Lake and north of Shakashi Lake; c) west of

Machimigemis Lake; and d) southwest of Localsh Bay, Dog Lake.

By defining the distribution of landforms and materials associated with retreat of the Laurentide Ice Sheet and by correcting terrace surface elevations to compensate for isostatic adjustment, hypothetical patterns of ice retreat and distribution of glacial lakes within the Wawa area can be reconstructed.

Glacial Ice Patterns

Phase A, Glacial Lake Minong I

The ice sheet position at the time of Glacial Lake Minong I is defined by the location of recessional moraines within the Michipicoten River valley and east of Trout Creek plus a significant area of ice-contact stratified drift within the Doré River valley. Two well-defined meltwater channels with glaciofluvial materials extend south from the recessional moraine within the Doré River valley and terminate at glacial lake Minong I (Figure 4a).

The aerial extent of Glacial Lake Minong I is defined by delta surfaces within the Magpie and Michipicoten river valleys and a delta surface (Saarnisto's Delta) at the northeastern end of the Wawa Lake basin (Figure 4a).

Phase B, Glacial Lake Minong I

A number of meltwater channels that extend from a series of east trending recessional moraine segments in the central part of the study area terminate at Glacial Lake Minong I. During this glacial lake phase the ice sheet retreated from the Wawa Lake basin and meltwater was directed south toward the Michipicoten River valley (Figure 4b).

Glacial Lake Minong I was in contact with the ice sheet within the Magpie River valley and the south end of the Whitefish Lake basin. At this time, 2 significant lakes formed between the ice sheet and higher ground within the Kinniwabi Lake basin and the Jackpine River valley (Figure 4b).

Phase C, Glacial Lake Minong I

A second series of recessional moraine segments exist north and northeast of those associated with Glacial Lake Minong I, Phase B. A series of spectacular meltwater channels formed during Phase C including 3 channels incised across ground that separates the Shikwamkwa Lake basin from the Shikwamkwa River valley (Figure 4c).

Glacial Lake Minong I continued to follow retreat of the ice margin into the Magpie River valley, Whitefish and Manitowik Lake basins and the Shikwamkwa River valley. The presence of deltas within these basins and valleys provides evidence of this

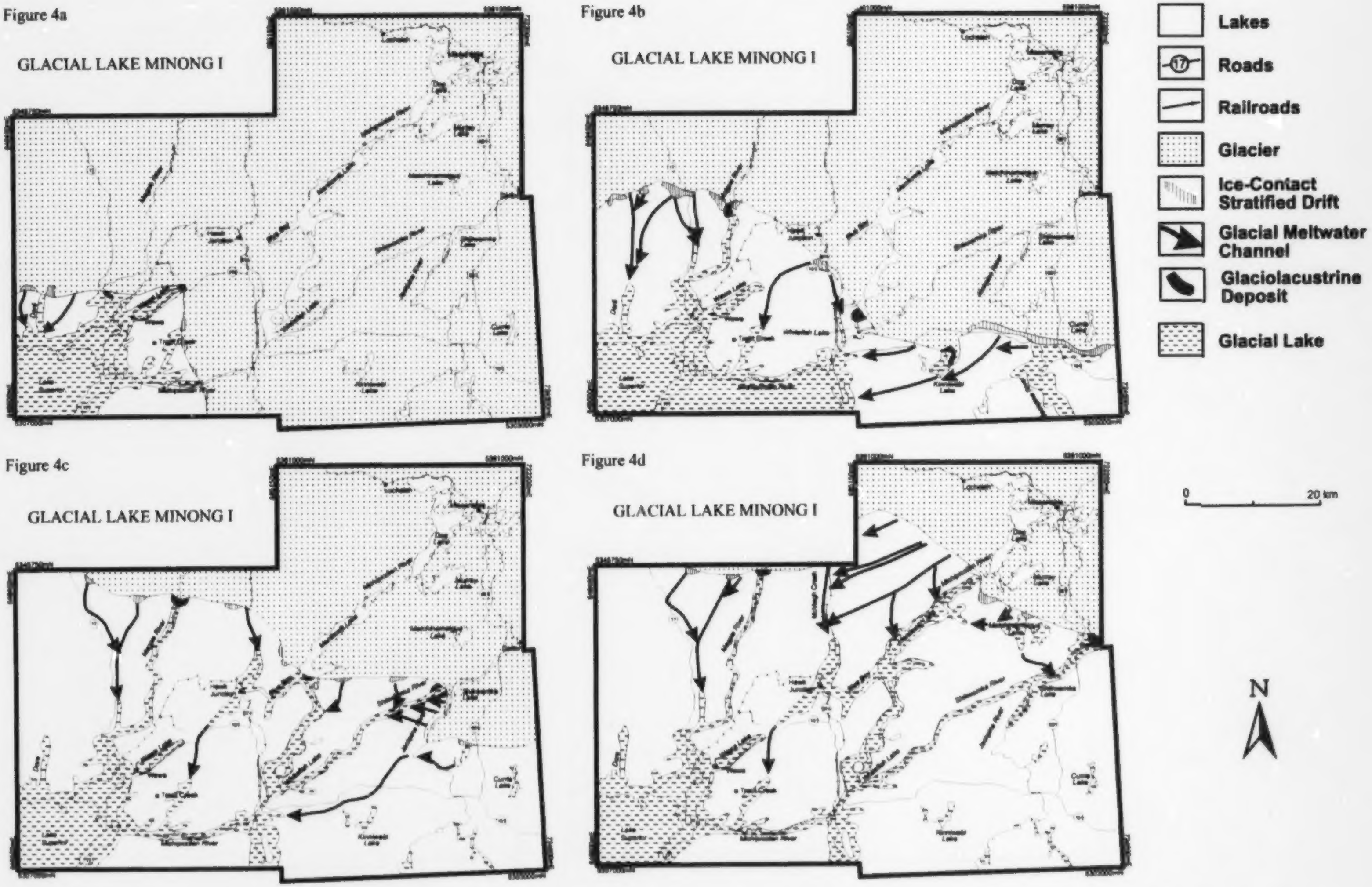


Figure 4a
GLACIAL LAKE MINONG I
Figure 4b
GLACIAL LAKE MINONG I
Figure 4c
GLACIAL LAKE MINONG I
Figure 4d
GLACIAL LAKE MINONG I
Lakes
17
Roads
Railroads
Glacier
Ice-Contact Stratified Drift
Glacial Meltwater Channel
Glaciolacustrine Deposit
Glacial Lake
0
20 km
N

Figure 4. Chronology of ice-sheet recession when Glacial Lake Minong I abutted the ice margin. Several well-defined meltwater channels developed in association with the retreating glacier. Most meltwater flowed freely to the Lake Superior basin, however, several smaller glacial lakes formed where meltwater was trapped between the ice sheet and higher ground.

glacial lake phase (Figure 4c).

Phase D, Glacial Lake Minong I

Continued retreat of the ice front to the north and northeast is indicated by a third series of recessional moraine segments. The position of the ice sheet in the east-central part of the study area at this time is defined by the presence of a series of northeast to southwest-oriented meltwater channels (Figure 4d).

The presence of Glacial Lake Minong I within the Magpie River valley and the Shikwamkwa Lake basin is defined by the presence of deltaic deposits in these areas. In addition, there is evidence of an impounded glacial lake that was located west of Machimigemis Lake (Figure 4d).

Phase E, Glacial Lake Minong I

The last significant still-stand of glacial ice is marked by a recessional moraine and associated meltwater channels located northwest of Localsh and south and east of Missanbie. Deltaic deposits east of Dog Lake indicate the presence of a small-impounded lake in that area (Figure 5a).

This phase represents near-maximum extent of Glacial Lake Minong I within the Wawa region. As ice retreated farther northeast glacial lake waters filled the Dog Lake basin (Figure 5a).

Phase F, Post-glacial Lake Minong

Once the ice sheet retreated from the area, lake levels fell dramatically. Waters occupying the Lake Superior basin inundated only as far inland as the Michipicoten River valley and part of the Magpie River valley (Figure 5b).

A barrier bar derived from reworked glaciolacustrine materials formed across the southwest end of Wawa Lake. It is on this barrier bar that the town of Wawa is built (Figure 5b).

Phase G, Houghton Level

By the time of Glacial Lake Houghton, significant lowering of the water within the Lake Superior basin had taken place. Only the lower reaches of the Magpie River valley and the Michipicoten River valley (Figure 5c) were inundated by this lake.

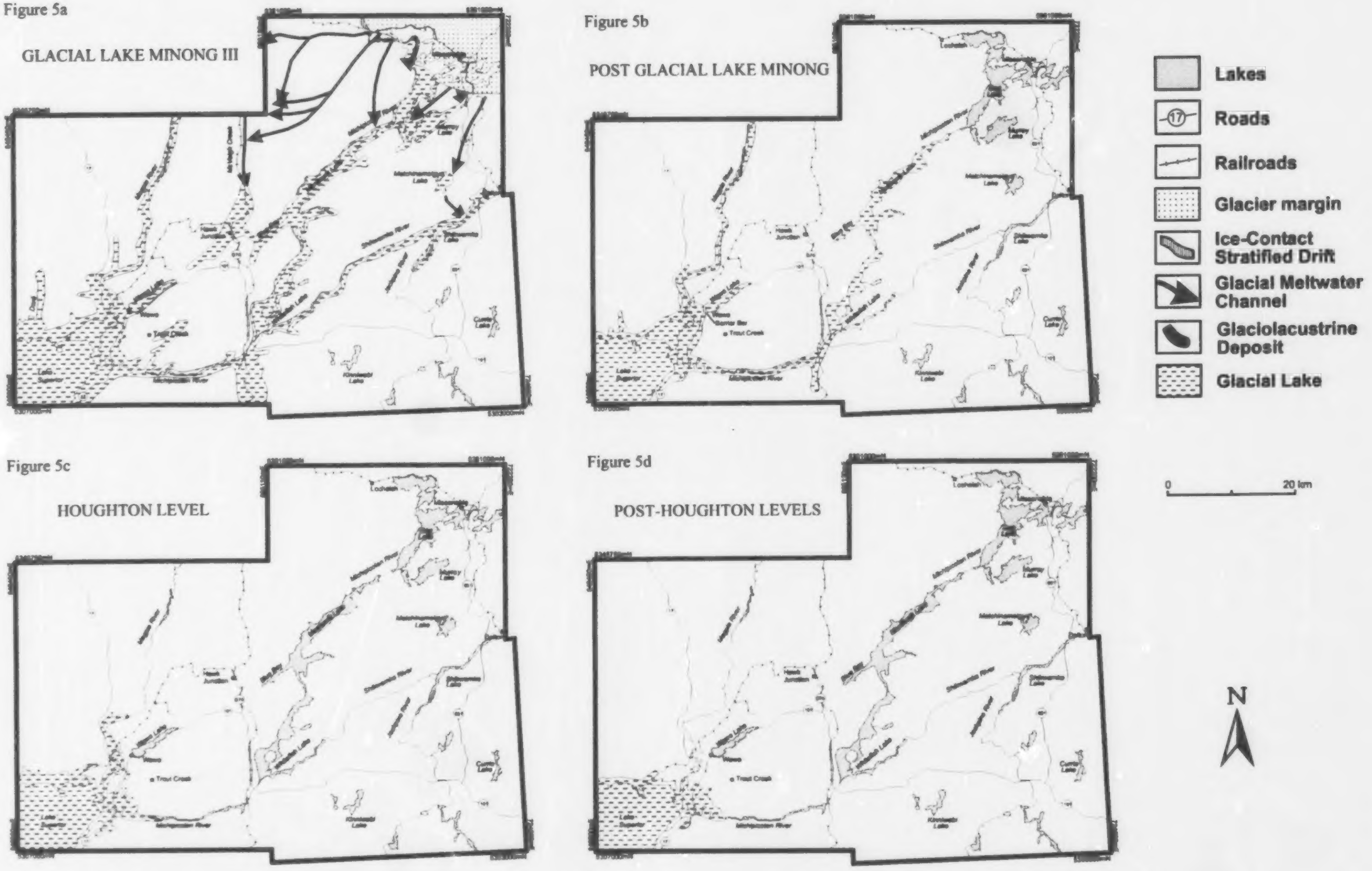


Figure 5a
GLACIAL LAKE MINONG III
Figure 5b
POST GLACIAL LAKE MINONG
Figure 5c
HOUGHTON LEVEL
Figure 5d
POST-HOUGHTON LEVELS
Lakes
Roads
17
Railroads
Glacier margin
Ice-Contact Stratified Drift
Glacial Meltwater Channel
Glaciolacustrine Deposit
Glacial Lake
0
20 km
N
Trout Creek
Michipicoten River
Lake Superior

Figure 5. Chronology of ice-sheet recession Glacial Lake Minong III to Post-Houghton period. When the ice sheet receeded from the area, lake levels within the Lake Superior basin gradually fell to present day levels. Description for each figure (Figures 5a-d) is provided in text.

Phase H, Post-Houghton Levels

Beaches and representing lakes Nipissing, Algoma, Sault and sub-Sault are all restricted to the mouths of the Magpie and Michipicoten rivers (Figure 5d).

Timing of Ice Retreat, Flora and Fauna Record

Two radiocarbon dates were obtained from organic material collected in the Wawa area. The first radiocarbon date was obtained from organic material sampled from the bottom of a 5.4 m core obtained from a bog located on the surface of a terrace within the Magpie River valley (Figure 6). The organic material from the core of the bog was radiocarbon dated at 9759 ± 170 BP (GSC 5914). However, Mothersill (1988) argues that radiocarbon dating of material from within the Lake Superior basin is potentially contaminated with old carbon. Using paleomagnetic dating, Mothersill (1988) concluded that the Lake Superior basin had been deglaciated by 8200 BP which agrees well with data compiled from Mahanic and Teller (1985).

The second radiocarbon date was obtained from a right shed antler of a caribou (Photograph 7). The antler was recovered from an aggregate operation downstream from the Magpie bog site. The antler was recovered from near the surface of the Minong III delta. The radiocarbon date of 8820 ± 80 BP (TO-6213) coincides well with radiocarbon dates elsewhere in the region of Minong III sediments (Farrand and Drexler 1985).

The Magpie bog is one of 3 bogs cored in the region and the paleoclimatic information derived from the Magpie bog is similar to the other 2 (Fortescue 1986, Fortescue et al. 1984). Three conclusions were derived from the Magpie bog core (Figure 6; J. McAndrews, paleontologist, personal communication, 1996):

1) Pollen analysis supports the radiocarbon ages for the abandonment of the high terrace; i.e., the dated horizon is in the correct pollen subzone;

2) A Lake Superior cold air mass may have been responsible for shortening clisseral succession in the early Holocene. As indicated on Figure 6, Zone 1 lacks the tundra subzone 1a; spruce and jackpine together directly invade a periglacial landscape. Similarly, birch and white pine migrate into a spruce-jack pine forest (subzone 1b) not into a jack pine forest (subzone 2a) as indicated from core elsewhere in northern Ontario;

3) The Wawa area experienced a 2.5° hypsithermal at 6500 years BP.

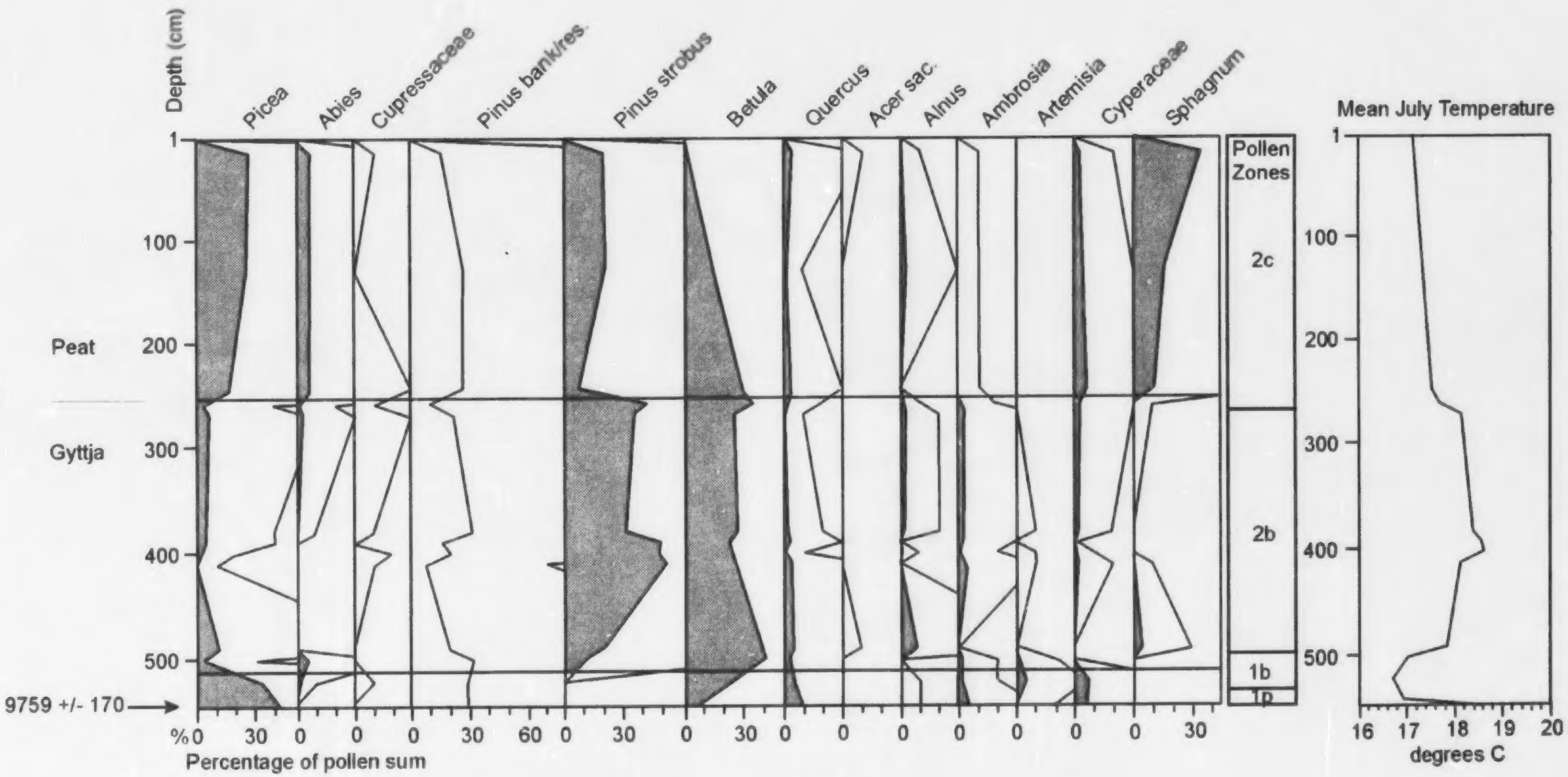
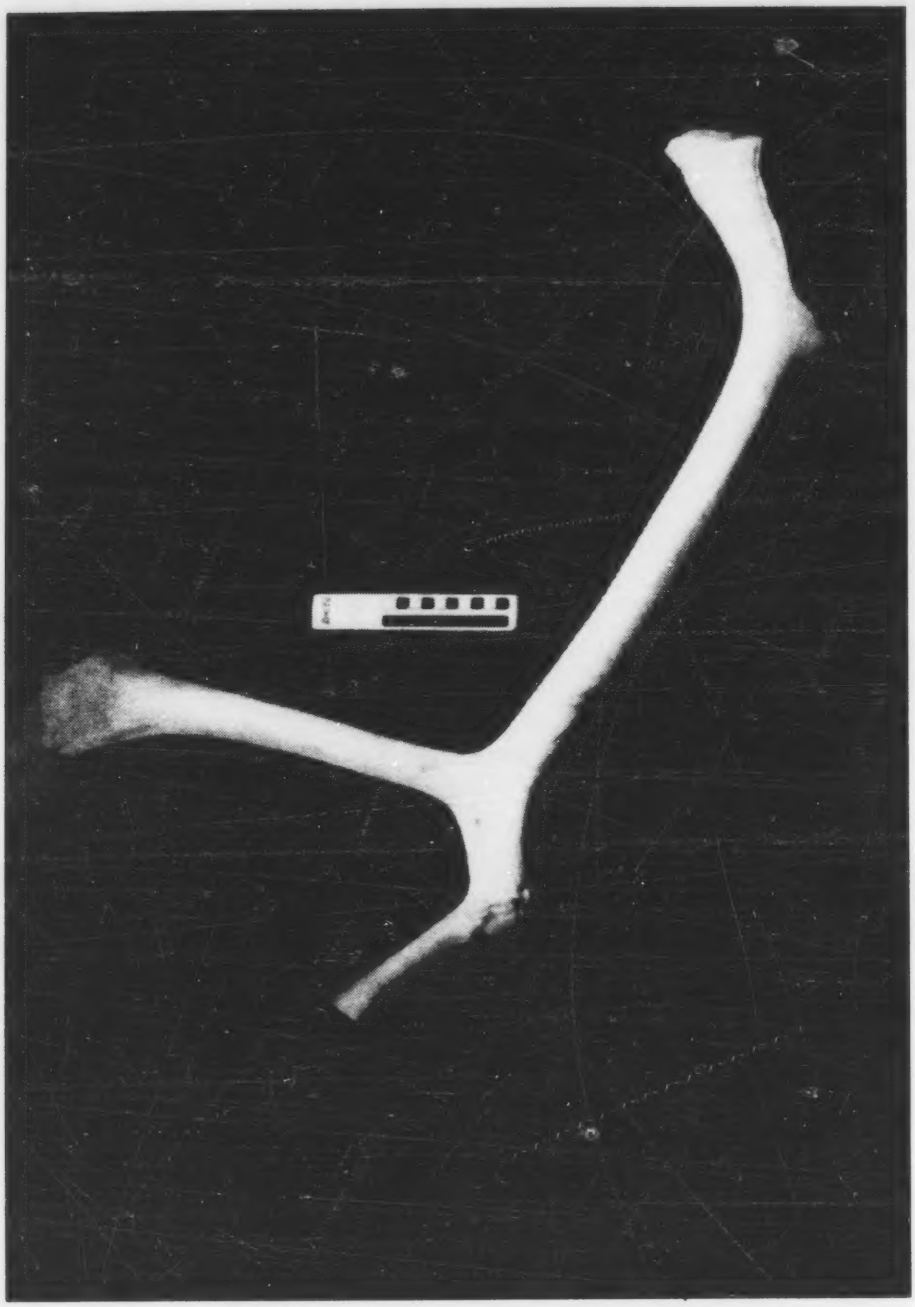


Figure 6. Pollen diagram for the Magpie bog. Presently the mean July temperature at nearby Wawa is 15.6°C.



Photograph 7. Caribou antler recovered near the surface of a delta at Tremblay Flats, representing Glacial Lake Minong (III). The antler has been radiocarbon dated at 8820 ± 80 years BP(TO-6213).

ACKNOWLEDGEMENTS

Guy Cousineau, Rob Hoag, Darice Cairns, Cate Searcy, James McDonald, Jennifer Chiupka and Mark Shaw provided excellent field assistance. Julie Tremblay drafted the figures. Cam Baker and Ross Kelly provided excellent reviews of the manuscript.

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Appendix A: Sample Site Locations

Summary List of Abbreviations

"A":	Soil "A" horizon
Ai:	Alkalic intrusive
"B":	Soil "B" horizon
"C":	Soil "C" horizon
C-Gl:	Coarse glaciolacustrine
Es:	Esker
F:	Franz
F-Gl:	Fine-grained glaciolacustrine
Fi:	Felsic instrusive
Fv:	Felsic metavolcanic
H:	Humus
HJ:	Hawk Junction
Ma:	Modern alluvium
Mg:	Migmatite
ML:	Manitowik Lake
Ms:	Metasedimentary
Mv:	Mafic metavolcanic
N.D.:	No Data
No.:	Number
Ow:	Outwash
P:	Pebble
Peb:	Pebble
R-Till:	Till associated with recessional moraine
TB:	Till "B" horizon
TC:	Till "C" horizon
TH:	Till-humus
Till Peb:	Till Pebble
TP:	Till Pebble
Tm:	Till matrix
Wad:	Acronym for samples collected by Darice Cairns
Waj:	Acronym for samples collected by James McDonald
Wat:	Acronym for samples collected by Tom Morris

APPENDIX A: Sample Site Locations

Sample No.	U.T.M.		Material	Terrane	Sample No.	U.T.M.		Material	Terrane
	Easting	Northing				Easting	Northing		
HJ-1	670200	5320700	Ow Peb	Mv	HJ-48	679800	5325500	R-Till "B"	Fi
HJ-2	670600	5320100	Till "A"	Fi	HJ-49	679800	5325500	Ow	Fi
HJ-3	670000	5319700	Ow Peb	Ms	HJ-50	679800	5325500	Ow	Fi
HJ-5	672600	5322100	F-Gl	Mv	HJ-51	679800	5325500	Ow Peb	Fi
HJ-6	672600	5322100	C-Gl	Mv	HJ-52	679800	5325500	R-Till "C"	Fi
HJ-7	673100	5322000	Ow Peb	Mv	HJ-53	679900	5331200	R-Till "C"	Mv
HJ-8	674600	5321700	Ow	Mv	HJ-54	679900	5331200	R-Till Peb	Mv
HJ-9	675300	5321900	Ow	Mv	HJ-55	668500	5326400	F-Gl	Ms
HJ-10	675300	5321900	Ow Peb	Mv	HJ-56	668500	5326400	Ow	Ms
HJ-11	675300	5321000	Till "B"	Mv	HJ-57	668500	5326400	Ow Peb	Ms
HJ-12	675100	5320000	R-Till "B"	Mv	HJ-59	682400	5338900	Ow Peb	Mv
HJ-13	680700	5319700	Ow	Fi	HJ-60	685400	5338700	Till "B"	Mv
HJ-14	680900	5319800	Till "B"	Fi	HJ-61	685400	5338700	Till Peb	Fi
HJ-15	683600	5320200	Ow Peb	Fi	HJ-63	682900	5337000	Till "B"	Fi
HJ-16	684000	5321000	Till "B"	Fi	HJ-63a	683600	5335900	Ow	Fi
HJ-17	684400	5323800	R-Till "B"	Fi	HJ-64	683600	5335900	Ow Peb	Fi
HJ-18	683300	5324800	Ow	Fi	HJ-65	676600	5344900	Till "B"	Mv
HJ-19	683300	5324800	Ow Peb	Fi	HJ-66	676600	5344900	Till Peb	Fv
HJ-20	679400	5324300	Ow	Fi	HJ-67	674500	5345200	Till Peb	Mv
HJ-21	668300	5325000	Till "B"	Mv	HJ-68	674300	5346300	Ow	Mv
HJ-21	668300	5325000	Till Peb	Mv	HJ-69	674300	5346300	F-Gl	Mv
HJ-22	668300	5325000	Ow	Mv	HJ-70	669900	5331000	Ow Peb	Mv
HJ-23	667100	5323600	Ow Peb	Fv	HJ-71	668900	5333300	Ow	Mv
HJ-24	667100	5323500	Ow	Fv	HJ-72	668900	5333100	Ow Peb	Mv
HJ-25	669800	5325700	Ow Peb	Ms	HJ-73	669600	5334100	R-Till "B"	Mv
HJ-26	669800	5325700	Ow	Ms	HJ-74	674200	5343900	Ow	Mv
HJ-27	672200	5323800	Till "B"	Mv	HJ-75	674200	5343900	Ow Peb	Mv
HJ-28	682900	5326300	R-Till "B"	Fi	HJ-77	659200	5343000	Till "B"	Mv
HJ-29	683500	5328300	Ow	Fi	HJ-78	659900	5341500	Ow	Mv
HJ-30	682400	5329700	Ow	Fi	HJ-79	659900	5341500	Ow Peb	Mv
HJ-31	683700	5332000	R-Till "B"	Fi	HJ-80	661500	5337900	Till "B"	Fv
HJ-32	683700	5332000	Till Peb	Fi	HJ-81	672000	5343400	Ow	Mv
HJ-33	681300	5330800	Ow	Fi	HJ-82	672000	5343400	Ow Peb	Mv
HJ-35	680100	5328700	R-Till "C"	Mv	HJ-83	671700	5341400	Till "B"	Mv
HJ-36	680100	5328700	R-Till "B"	Mv	HJ-84	671100	5341000	Till "B"	Fv
HJ-37a	680100	5328700	R-Till Peb	Mv	HJ-86	670300	5339800	Till "A"	Mv
HJ-37b	680100	5328700	R-Till Peb	Mv	HJ-87	669600	5341400	Till "A"	Fv
HJ-38	679400	5329800	R-Till "C"	Mv	HJ-88	667800	5343700	Till "A"	Fe
HJ-39	679400	5329800	R-Till "B"	Mv	HJ-89	650400	5343700	Till "B"	Mv
HJ-41	682300	5326400	Ow Peb	Fi	HJ-90	660600	5344600	Ow	Mv
HJ-42	678000	5330700	Till "B"	Mv	HJ-91	660300	5345200	Ow	Ms
HJ-43	676100	5328200	R-Till "B"	Mv	HJ-92	660300	5345200	Ow Peb	Ms
HJ-45	674600	5328400	Ow	Fv	HJ-93	671700	5330900	Ow	Mv
HJ-46	674200	5327400	Ow	Fv	HJ-94	671700	5330000	Ow	Mv
HJ-47	674200	5327400	Ow Peb	Fv	HJ-95	660600	5336700	Till "B"	Fv

APPENDIX A: Sample Site Locations (Continued)

Sample No.	U.T.M.		Material	Terrane	Sample No.	U.T.M.		Material	Terrane
	Easting	Northing				Easting	Northing		
HJ-96	662900	5335700	Till "A"	Ms	HJ-143	653200	5333700	Ow	Fi
HJ-97	662900	5333400	R-Till "B"	Ms	HJ-144	653200	5333700	Ow Peb	Fi
HJ-98	662800	5332200	Ow	Mv	HJ-145	661200	5326600	Till "B"	Fv
HJ-99	662800	5332200	Ow Peb	Mv	HJ-146	661500	5321700	C-Gl	Fi
HJ-101	662000	5330000	Till "B"	Fv	HJ-147	661500	5321700	Ow Peb	Fi
HJ-102	663100	5328700	Ow	Fi	HJ-148	661500	5321700	F-Gl	Fi
HJ-103	663100	5328700	Ow	Fi	HJ-149	659600	5321200	Till "B"	Ms
HJ-104	668000	5363300	Till "B"	Fv	HJ-150	658200	5320900	Ow	Ms
HJ-105	664400	5326700	Till "B"	Mv	HJ-151	658200	5320900	Ow Peb	Ms
HJ-106	664400	5326700	Ow	Mv	HJ-152	657500	5321600	R-Till "C"	Ms
HJ-107	664400	5326700	Ow Peb	Mv	HJ-153	657500	5321600	R-Till Peb	Ms
HJ-108	666800	5327000	Ow	Mv	HJ-154	657300	5322500	Till "B"	Mv
HJ-109	666800	5327000	Ow Peb	Mv	HJ-155	656500	5324000	Till "B"	Fi
HJ-110	667900	5327200	Till "B"	Ms	HJ-156	655800	5325300	Ow	Fi
HJ-112	656100	5342900	Till "B"	Fv	HJ-157	655800	5325300	Ow Peb	Fi
HJ-113	655400	5342300	Till "B"	Mv	HJ-158	651200	5329300	Till "B"	Fi
HJ-114	654900	5343200	Till "B"	Fv	HJ-159	653900	5324100	C-Gf	Fi
HJ-115	654300	5343200	Ow	Fi	HJ-160	653900	5323900	R-Till "C"	Fi
HJ-116	654300	5343200	Ow Peb	Fi	HJ-161	653900	5323900	R-Till "B"	Fi
HJ-117	653300	5342800	Till "B"	Fi	HJ-162	653900	5323900	R-Till Peb	Fi
HJ-118	654800	5341700	Till "B"	Mv	HJ-163	653900	5323600	F-Gl	Fi
HJ-119	658800	5336500	Till "B"	Mv	HJ-164	653500	5323100	R-Till "B"	Fi
HJ-120	658800	6336500	Till Peb	Mv	HJ-165	653100	5323500	R-Till "C"	Fi
HJ-121	659400	5335500	Ow	Mv	HJ-166	653100	5326500	R-Till Peb	Fi
HJ-122	659400	5335500	Ow Peb	Mv	HJ-167	650700	5322900	Ow	Fi
HJ-123	658400	5335500	R-Till "B"	Mv	HJ-168	650700	5322900	Ow Peb	Fi
HJ-124	657400	5335800	Till "B"	Mv	HJ-169	649600	5323100	Till "B"	Fi
HJ-125	655000	5335600	R-Till "B"	Mv	HJ-170	649100	5327400	Till "A"	Fi
HJ-126	656200	5335600	R-Till "B"	Mv	HJ-172	650000	5328200	Ow Peb	Fi
HJ-127	656200	5335600	R-Till Peb	Mv	HJ-173	653200	5328900	Ow	Fi
HJ-128	656600	5333400	Till "B"	Mv	HJ-174	653200	5328900	Ow Peb	Fi
HJ-129	657300	5333000	Till "B"	Mv	HJ-175	652600	5331200	Ow	Fi
HJ-130	657500	5333000	Till "B"	Mv	HJ-176	652600	5331200	Ow Peb	Fi
HJ-131	657500	5333000	Till Peb	Mv	HJ-177	653800	5329700	Ow	Fi
HJ-132	656800	5331700	Till "B"	Ms	HJ-178	653800	5329700	Ow Peb	Fi
HJ-133	655700	5331600	Ow	Fi	HJ-180	661400	5322300	Ow	Ms
HJ-134	655700	6331600	Ow Peb	Fi	HJ-181	661400	5322300	Ow Peb	Ms
HJ-135	654300	5332500	Ow	Fi	HJ-182	661500	5321100	Till "B"	Fi
HJ-136	654300	5332500	Ow Peb	Fi	HJ-183	659800	5329500	R-Till "C"	Fi
HJ-137	652900	5331900	Ow	Fi	HJ-185	656000	5327800	R-Till "C"	Fi
HJ-138	652900	5331900	Ow Peb	Fi	91HJ01	661400	5340300	Humus	Mv
HJ-139	652100	5332300	Till "B"	Fi	91HJ02	661400	5340300	Till "B"	Mv
HJ-140	649200	5333900	Till "B"	Fi	91HJ03	661400	5340300	Till Peb	Mv
HJ-141	651400	5332700	Ow	Fi	91HJ04	661200	5340100	Humus	Mv
HJ-142	651400	5332700	Ow Peb	Fi	91HJ05	661200	5340100	Till "B"	Mv

APPENDIX A: Sample Site Locations (Continued)

Sample No.	U.T.M.		Material	Terrane	Sample No.	U.T.M.		Material	Terrane
	Easting	Northing				Easting	Northing		
91HJ06	661200	5340100	Till Peb	Mv	91HJ54	660000	5336900	Till "B"	Mv
91HJ07	661100	5339900	Till "A"	Fv	91HJ55	660000	5336900	Till Peb	Mv
91HJ08	661100	5339900	Till "B"	Fv	91HJ56	660800	5338100	Till "B"	Fv
91HJ09	661100	5339900	Till Peb	Fv	91HJ57	660800	5338100	Till Peb	Fv
91HJ10	661000	5339800	Till "B"	Fv	91HJ58	660100	5338300	Till "B"	Fv
91HJ11	661000	5339800	Till Peb	Fv	91HJ59	660100	5338300	Till Peb	Fv
91HJ12	660900	5339600	Till "B"	Fv	91HJ60	661700	5339500	Till "B"	Mv
91HJ13	660900	5339600	Till Peb	Fv	91HJ61	680300	5328900	Till Peb	Mv
91HJ15	660800	5339400	Till "B"	Fv	91HJ62	661600	5339400	Humus	Mv
91HJ16	660800	5339400	Till Peb	Fv	91HJ63	661600	5339400	Till "A"	Mv
91HJ18	660700	5339200	Till Peb	Fv	91HJ64	661600	5339400	Till "B"	Mv
91HJ19	660500	5339100	Humus	Fv	91HJ65	661600	5339400	Till Peb	Mv
91HJ20	660500	5339100	Till "B"	Fv	91HJ66	661500	5339200	Till "B"	Fv
91HJ21	680500	5339100	Till Peb	Fv	91HJ67	661500	5339200	Till Peb	Fv
91HJ22	659700	5337800	Till "B"	Mv	91HJ68	661400	5339000	Humus	Fv
91HJ23	659700	5337800	Till Peb	Mv	91HJ69	661400	5339000	Till "B"	Fv
91HJ24	659800	5337900	Till "B"	Mv	91HJ70	661400	5339000	Till Peb	Fv
91HJ25	659800	5337900	Till Peb	Mv	91HJ71	661300	5338800	Till "A"	Fv
91HJ26	659900	5338100	Humus	Fv	91HJ72	661300	5338800	Till "B"	Fv
91HJ27	659900	5338100	Till "B"	Fv	91HJ73	661300	5338800	Till Peb	Fv
91HJ28	659900	5338100	Till Peb	Fv	91HJ74	661200	5338600	Till "B"	Fv
91HJ29	660000	5338200	Till "B"	Fv	91HJ75	661200	5338600	Till Peb	Fv
91HJ30	660000	5338200	Till Peb	Fv	91HJ76	661100	5338500	Till "B"	Fv
91HJ31	660100	5338400	Till "B"	Fv	91HJ77	661100	5338500	Till Peb	Fv
91HJ32	526200	5334800	Till Peb	Fv	91HJ78	661200	5337800	Humus	Fv
91HJ33	660200	5338600	Humus	Fv	91HJ79	661200	5337800	Till "A"	Fv
91HJ34	660200	5338600	Till "B"	Fv	91HJ80	661200	5337800	Till "B"	Fv
91HJ35	660200	5338600	Till Peb	Fv	91HJ81	661200	5337800	Till Peb	Fv
91HJ36	660200	5338600	Till "A"	Fv	91HJ82	661300	5337900	Till "B"	Fv
91HJ37	660300	5338800	Till "B"	Fv	91HJ83	680300	5337900	Till Peb	Fv
91HJ38	660300	5338800	Till Peb	Fv	91HJ84	661100	5337500	Till "B"	Fv
91HJ39	660600	5337800	Till "A"	Fv	91HJ85	661100	5337500	Till Peb	Fv
91HJ40	660600	5337800	Till "B"	Fv	91HJ86	661000	5337400	Till "B"	Fv
91HJ41	660600	5337800	Till Peb	Fv	91HJ87	661000	5337400	Till Peb	Fv
91HJ42	660500	5337600	Till "B"	Fv	91HJ88	660900	5337200	Till "B"	Fv
91HJ43	660500	5337600	Till Peb	Fv	91HJ89	660900	5337200	Till Peb	Fv
91HJ44	660400	5337500	Till "B"	Fv	91HJ90	660800	5337000	Till "B"	Fv
91HJ45	660400	5337500	Till Peb	Fv	91HJ91	660800	5337000	Till Peb	Fv
91HJ46	660300	5337300	Till "B"	Fv	91HJ92	660700	5336900	Till "B"	Fv
91HJ47	660300	5337300	Till Peb	Fv	91HJ93	526200	5384800	Till Peb	Fv
91HJ48	660200	5337100	Humus	Mv	91HJ94	660500	5336600	Till "B"	Mv
91HJ49	660200	5337100	Till "A"	Mv	91HJ95	660500	5336600	Till Peb	Mv
91HJ51	660200	5337100	Till Peb	Mv	91HJ96	660300	5336300	Humus	Mv
91HJ52	660100	5337000	Till "B"	Mv	91HJ97	660300	5336300	Till "B"	Mv
91HJ53	660100	5337000	Till Peb	Mv	91HJ98	660300	5336300	Till Peb	Mv

APPENDIX A: Sample Site Locations (Continued)

Sample No.	U.T.M.		Material	Terrane	Sample No.	U.T.M.		Material	Terrane
	Easting	Northing				Easting	Northing		
91HJ99	660400	5336500	Till "B"	Mv	91F141	707500	5359800	Till "B"	Mv
91HJ100	660400	5336500	Till Peb	Mv	91F142	707500	5359800	Till Peb	Mv
91HJ101	662200	5338900	Humus	Mv	91F144	708500	5360100	Till "B"	Ms
91HJ102	662200	5338900	Till "B"	Mv	91F145	708500	5360100	Till Peb	Ms
91HJ103	662200	5338900	Till Peb	Mv	91F147	712200	5358500	Till "B"	Mv
91HJ104	662100	5338800	Till "A"	Mv	91F148	712200	5358500	Till Peb	Mv
91HJ105	662100	5338800	Till Peb	Mv	91F149	712100	5356700	Till "B"	Mv
91HJ106	662000	5338700	Till "B"	Mv	91F150	712100	5356700	Till Peb	Mv
91HJ107	662000	5338700	Till Peb	Mv	91F151	710400	5355500	Till "B"	Fi
91HJ108	661900	5338500	Till "B"	Mv	91F152	710400	5355500	Till Peb	Fi
91HJ109	661900	5338500	Till Peb	Mv	91F153	714500	5356700	Till "B"	Mv
91HJ110	661800	5338400	Till "B"	Fv	91F154	714500	5356700	Till Peb	Mv
91HJ111	661800	5338400	Till Peb	Fv	91F155	714700	5352600	Till "B"	Fi
91HJ112	661700	5338200	Humus	Fv	91F156	714700	5352600	Till Peb	Fi
91HJ113	661700	5338200	Till "B"	Fv	91F157	708900	5354200	R-Till "B"	Mv
91HJ114	661700	5338200	Till Peb	Fv	91F158	708900	5354200	R-Till Peb	Mv
91HJ115	661700	5338000	Till "B"	Fv	91F159	709700	5352500	Till "B"	Mv
91HJ116	661700	5338000	Till Peb	Fv	91F160	709700	5352500	Till Peb	Mv
91HJ117	661500	5337900	Till "B"	Fv	91F161	709800	5349400	Till "B"	Fi
91HJ118	661500	5337900	Till Peb	Fv	91F162	709800	5349400	Till Peb	Fi
91F119	689300	5352300	Till "B"	Mv	91F163	712500	5351300	Till "B"	Fi
91F119	689300	5352300	Till "C"	Mv	91F164	712500	5351300	Till Peb	Fi
91F120	689300	5352300	Till Peb	Mv	91F165	712800	5352700	Till "B"	Mv
91F121	689400	5352600	Till "B"	Mv	91F166	712800	5352700	Till Peb	Mv
91F121	689400	5352600	Till "C"	Mv	91ML167	709800	5352700	Till "A"	Mv
91F122	689400	5352600	Till Peb	Mv	91ML168	709800	5343200	Till "B"	Mv
91F123	689500	5352700	Till "B"	Mv	91ML169	709800	5343200	Till Peb	Mv
91F123	689500	5352700	Till "C"	Mv	91ML170	710100	5344600	Till "B"	Fi
91F124	689500	5352700	Till Peb	Mv	91ML171	710100	5344600	Till Peb	Fi
91F125	689600	5353200	Till "B"	Mv	91ML172	707900	5345000	Till "B"	Mv
91F125	689600	5353200	Till "C"	Mv	91ML173	707900	5345000	Till Peb	Mv
91F126	689600	5353200	Till Peb	Mv	91ML174	707700	5343300	Till "B"	Mv
91F127	689700	5353600	R-Till "C"	Mv	91ML175	707700	5343300	Till Peb	Mv
91F128	689700	5353600	R-Till Peb	Mv	91ML176	710900	5347100	Till "B"	Fi
91F129	689700	5353600	R-Till "C"	Mv	91ML177	710900	5347100	Till Peb	Fi
91F130	672200	5323800	R-Till Peb	Mv	91ML178	712800	5345500	Till "B"	Fi
91F131	682100	5330900	Till "B"	Fi	91ML179	712800	5345500	Till Peb	Fi
91F132	682100	5330900	Till Peb	Fi	91ML180	713200	5346900	Till "B"	Fi
91F133	709300	5358000	Till "B"	Mv	91ML181	713200	5346900	Till Peb	Fi
91F134	709300	5358000	Till Peb	Mv	91ML182	715700	5347600	Till "B"	Fi
91F136	707400	5357700	Ma	Mv	91ML183	715700	5347600	Till Peb	Fi
91F137	705800	5358300	Till "B"	Ai	91F184	707200	5349700	Till "B"	Mv
91F138	705800	5358300	Till Peb	Ai	91F185	707200	5349700	Till Peb	Mv
91F139	705800	5359700	R-Till "B"	Mv	91F186	706600	5348000	Till "B"	Mv
91F140	705800	5359700	R-Till Peb	Mv	91F187	706600	5348000	Till Peb	Mv

APPENDIX A: Sample Site Locations (Continued)

Sample No.	U.T.M.		Material	Terrane	Sample No.	U.T.M.		Material	Terrane
	Easting	Northing				Easting	Northing		
91ML188	706500	5346700	Till "B"	Mv	91ML235	718700	5346200	Till "B"	Mv
91ML189	706500	5346700	Till Peb	Mv	91ML236	718700	5346200	Till Peb	Mv
91ML190	705500	5345000	Till "B"	Mv	91ML237	659900	5344900	Till "B"	Mv
91ML191	705500	5345000	Till Peb	Mv	91ML238	659900	5344900	Till Peb	Mv
91ML192	707700	5346400	Till "B"	Mv	91ML239	659400	5344600	Till "B"	Fi
91ML193	707700	5346400	Till Peb	Mv	91ML240	659400	5344600	Till Peb	Fi
91ML194	708800	5347500	R-Till "B"	Fi	91F241	658900	5344400	Till "B"	Fi
91ML195	708800	5347500	R-Till Peb	Fi	91F242	658900	5344400	Till Peb	Fi
91F196	713800	5357400	Till "A"	Mv	91F243	658900	5344400	Till "C"	Fi
91F197	713800	5357400	Till "B"	Mv	91F244	658900	5344400	Till Peb	Fi
91F198	713800	5357400	Till Peb	Mv	91F245	658500	5344300	Till "B"	Fi
91F199	669900	5331000	R-Till "B"	Fi	91F246	658500	5344300	Till Peb	Fi
91F200	669900	5331000	R-Till Peb	Fi	91F247	671700	5330600	Till "B"	Fv
91ML201	672500	5341300	Till "B"	Fi	91F248	671700	5330600	Till Peb	Fv
91ML202	672500	5341300	Till Peb	Fi	91F249	671700	5330000	Till "B"	Fv
91ML203	673500	5341500	R-Till "B"	Fi	91F250	671700	5330000	Till Peb	Fv
91ML204	673500	5341500	R-Till Peb	Fi	91F251	669400	5330800	Till "B"	Fv
91ML205	719200	5335200	Till "B"	Fi	91F252	669400	5330800	Till Peb	Fv
91ML206	719200	5335200	Till Peb	Fi	91F253	668400	5329500	Till "B"	Fi
91ML208	718900	5337200	C-Gl	Fi	91F254	668400	5329500	Till Peb	Fi
91ML209	718200	5337200	Till "B"	Fi	91F255	721000	5355600	Till "B"	Fi
91ML210	718200	5337200	Till Peb	Fi	91F256	721000	5355600	Till Peb	Fi
91ML211	716200	5335800	Till "B"	Fi	91F257	716500	5355900	Till "B"	Fi
91ML212	716200	5335800	Till Peb	Fi	91F258	716500	5355900	Till Peb	Fi
91ML213	715500	5337500	Till "B"	Mv	91F259	662900	5334400	Till "B"	Fi
91ML214	715500	5337500	Till Peb	Mv	91F260	662900	5334400	Till Peb	Fi
91ML215	714900	5339000	Till "B"	Mv	91F264	659000	5335700	Till "B"	Fv
91ML216	714900	5339000	Till Peb	Mv	91F265	659000	5335700	Till Peb	Fv
91ML217	716200	5339200	Till "B"	Mv	91F266	658300	5335600	R-Till "B"	Ai
91ML218	716200	5339200	Till Peb	Mv	91F267	658300	5335600	R-Till Peb	Ai
91ML219	711100	5341500	Till "B"	Mv	91F268	657500	5335700	R-Till "B"	Mv
91ML220	711100	5341500	Till Peb	Mv	91F269	657500	5335700	R-Till Peb	Mv
91ML221	711300	5339900	Till "B"	Mv	91F270	655400	5335600	Till "B"	Fi
91ML222	711300	5339900	Till Peb	Mv	91F271	655400	5335600	Till Peb	Fi
91ML223	716800	5341600	Till "B"	Fi	91F272	655800	5335600	Till "B"	Fi
91ML224	716800	5341600	Till Peb	Fi	91F273	655800	5335600	Till Peb	Fi
91ML225	716800	5342700	Till "B"	Mv	91F274	656000	5335600	Till "B"	Ms
91ML226	716800	5342700	Till Peb	Mv	91F275	656000	5335600	Till Peb	Ms
91ML227	716500	5343600	Till "B"	Fi	91F276	656500	5335600	Till "B"	Fi
91ML228	716500	5343600	Till Peb	Fi	91F277	656500	5335600	Till Peb	Fi
91F229	722000	5348400	Till "B"	Mv	91F278	658700	5335400	Till "B"	Mv
91F230	722000	5348400	Till Peb	Mv	91F279	658700	5335400	Till Peb	Mv
91ML231	721000	5347700	Till "B"	Mv	91F280	657900	5334800	Till "B"	Fi
91ML232	721000	5347700	Till Peb	Mv	91F281	657900	5334800	Till Peb	Fi
91ML234	621000	5347700	Till Peb	Mv	91F282	657500	5333000	Till "B"	Mv

APPENDIX A: Sample Site Locations (Continued)

Sample No.	U.T.M.		Material	Terrane
	Easting	Northing		
91F283	657500	5333000	Till Peb	Mv
91F284	657700	5333000	Till "B"	Mv
91F285	657700	5333000	Till Peb	Mv
91F286	658000	5332700	Till "B"	Mv
91F287	658000	5332700	Till Peb	Mv
91F288	657400	5331800	Till "B"	Mv
91F289	657400	5331800	Till Peb	Mv
91F290	656800	5331800	R-Till "B"	Mv
91F291	656800	5331800	R-Till Peb	Mv
91F292	656200	5331700	Till "B"	Fi
91F293	656200	5331700	Till Peb	Fi
91F294	655100	5332000	Till "B"	Fv
91F295	655100	5332000	Till Peb	Fv
91F296	652800	5331800	Till "B"	Fv
91F297	652800	5331800	Till "A"	Fv
91F298	652800	5331800	Till Peb	Fv
91ML300	651600	5333400	Till "B"	Mv
91ML301	651600	5333400	Till Peb	Mv
91ML302	651600	5333400	Till "C"	Mv
91ML303	651600	5333400	Till Peb	Mv
91ML304	654200	5331300	Till "B"	Mv
91ML305	654200	5331300	Till Peb	Mv
91ML306	654200	5331300	Till "C"	Mv
91ML307	654200	5331300	Till Peb	Mv
91ML308	690800	5340800	Till "B"	Mv
91ML309	690800	5340800	Till Peb	Mv
91ML310	692900	5343000	Till "B"	Mv
91ML311	692900	5343000	Till Peb	Mv
91ML312	693200	5344000	Till "B"	Mv
91ML313	693200	5344000	Till Peb	Mv
91ML314	693500	5345500	Till "B"	Mv
91ML315	693500	5345500	Till Peb	Mv
91ML316	692100	5346200	Till "B"	Mv
91ML317	692100	5346200	Till Peb	Mv
91F318	692000	5347500	Till "B"	Fi
91F319	692000	5347500	Till Peb	Fi
91F320	691800	5349900	Till "B"	Fv
91F321	691800	5349900	Till Peb	Fv
91F322	691400	5355700	Till "B"	Fi
91F323	691400	5355700	Till Peb	Fi
91F324	696600	5354900	Till "B"	Mv
91F325	696600	5354900	Till Peb	Mv
91ML326	695500	5355800	Till "B"	Mv
91ML327	695500	5355800	Till Peb	Mv
91ML328	652600	5323400	Till "B"	Mv
91ML329	652600	5353400	Till Peb	Mv
91ML330	652500	5323300	Till "B"	Mv
91ML331	652500	5323300	Till Peb	Mv
91ML332	652100	5323500	Till "B"	Mv
91ML333	652100	5323500	Till Peb	Mv
91F334	651000	5323000	Till "B"	Mv
91F335	651000	5323000	Till Peb	Mv
91F336	650900	5322900	Till "B"	Mv
91F337	650900	5322900	Till Peb	Mv
91F338	700500	5349800	Till "B"	Mv
91F339	700500	5349800	Till Peb	Mv
91F340	650500	5322000	Till "B"	Mv
91F341	650500	5322000	Till Peb	Mv
91F342	649900	5322100	Till "B"	Fi
91F343	649900	5322100	Till Peb	Fi
91ML344	649500	5323200	Till "B"	Mv
91ML345	649500	5328900	Till Peb	Mv
91ML346	649200	5327400	R-Till "B"	Mv
91ML347	649200	5327400	R-Till Peb	Mv
91ML348	649600	5327800	Till "B"	Fi
91ML349	649600	5327800	Till Peb	Fi
91ML350	690400	5333400	Till "B"	Fi
91ML351	690400	5333400	Till Peb	Fi
91ML352	691700	5335700	Till "B"	Fi
91ML353	691700	5335700	Till Peb	Fi
91ML354	693200	5337800	Till "B"	Fi
91ML355	693200	5337800	Till Peb	Fi
91ML356	693200	5337800	Till "B"	Fi
91ML357	693100	5337900	F-Gl	Fi
91ML358	695400	5339000	Till "B"	Mv
91ML359	695400	5339000	Till Peb	Mv
91ML360	697100	5339800	Till "B"	Mv
91ML361	697100	5339800	Till Peb	Mv
91ML362	698000	5341200	Till "B"	Mv
91ML363	698000	5341200	Till Peb	Mv
91ML364	691400	5334500	Till "B"	Fi
91ML365	691400	5334500	Till Peb	Fi
91ML366	692500	5333800	Till "B"	Fi
91ML367	692500	5333800	Till Peb	Fi
91ML368	699800	5341800	Till "B"	Mv
91ML369	699800	5341800	Till Peb	Mv
91ML370	701600	5342800	Till "B"	Mv
91ML371	701600	5342800	Till Peb	Mv
91ML372	702800	5344300	Till "B"	Mv
91ML373	702800	5344300	Till Peb	Mv

APPENDIX A: Sample Site Locations (Continued)

Sample No.	U.T.M.		Material	Terrane	Sample No.	U.T.M.		Material	Terrane
	Easting	Northing				Easting	Northing		
91ML374	700100	5339600	Till "B"	Mv	91HJ419	681400	5330200	Till "B"	Mv
91ML375	700100	5384800	Till Peb	Mv	91HJ420	681400	5330200	Till Peb	Mv
91ML376	697500	5338700	Till "B"	Fi	91HJ421	674600	5346200	Till "B"	Mv
91ML377	697500	5338700	Till Peb	Fi	91HJ422	674600	5346200	Till Peb	Mv
91ML378	696300	5337500	Till "B"	Fi	91HJ423	675500	5345600	Till "B"	Mv
91ML379	696300	5337500	Till Peb	Fi	91HJ424	675500	5345600	Till Peb	Mv
91ML380	696300	5337500	Till "A"	Fi	91HJ425	678800	5345000	Till "B"	Mv
91ML381	693500	5334900	Till "B"	Fi	91HJ426	678800	5345000	Till Peb	Mv
91ML382	693500	5334900	Till Peb	Fi	91HJ427	679500	5345500	Till "B"	Mv
91ML383	695200	5336500	Till "B"	Fi	91HJ428	679500	5345500	Till Peb	Mv
91ML384	695200	5336500	Till Peb	Fi	91HJ429	680100	5346100	Till "B"	Mv
91HJ385	674200	5344700	Till "B"	Mv	91HJ430	680100	5346100	Till Peb	Mv
91HJ386	674200	5344700	Till Peb	Mv	91HJ431	682800	5345600	Till "B"	Fv
91HJ387	673300	5343000	Till "B"	Mv	91HJ432	682800	5345600	Till Peb	Fv
91HJ388	673300	5343000	Till Peb	Mv	91HJ433	659600	5342500	Till "B"	Mv
91HJ389	672100	5343300	Till "B"	Mv	91HJ434	659600	5342500	Till Peb	Mv
91HJ390	672100	5343300	Till Peb	Mv	91HJ435	659700	5340500	Till "B"	Ms
91HJ391	673600	5341700	Till "B"	Mv	91HJ436	659700	5340500	Till Peb	Ms
91HJ392	673600	5341700	Till Peb	Mv	91HJ437	649500	5323400	Till "B"	Fi
91HJ393	671000	5338700	Till "B"	Mv	91HJ438	649500	5323400	Till Peb	Fi
91HJ394	671000	5338700	Till Peb	Mv	91HJ439	651100	5321900	R-Till "B"	Fi
91HJ395	670500	5336300	R-Till "B"	Mv	91HJ440	651100	5321900	R-Till Peb	Fi
91HJ396	670500	5336300	R-Till Peb	Mv	91HJ441	655100	5322200	Till "B"	Fi
91HJ397	668900	5335700	R-Till "B"	Mv	91HJ442	655100	5322200	Till Peb	Fi
91HJ398	668900	5335700	R-Till Peb	Mv	91HJ443	653200	5330700	Till "B"	Fi
91HJ399	668000	5332800	R-Till "B"	Mv	91HJ444	653200	5330700	Till Peb	Fi
91HJ400	668000	5332800	R-Till Peb	Mv	91HJ445	649700	5333500	Till "B"	Fi
91HJ401	669800	5330400	Till "B"	Mv	91HJ446	649700	5333500	Till Peb	Fi
91HJ402	669800	5330400	Till Peb	Mv	91HJ447	659700	5329200	R-Till "B"	Fi
91HJ403	667700	5330800	Till "B"	Fv	91HJ448	659700	5329200	R-Till Peb	Fi
91HJ404	667700	5384800	Till Peb	Fv	91HJ449	658000	5327900	R-Till "B"	Fi
91HJ405	682800	5343800	Till "B"	Mv	91HJ450	658000	5327900	R-Till Peb	Fi
91HJ406	682800	5343800	Till Peb	Mv	91HJ451	656000	5327700	R-Till "B"	Fi
91HJ407	683400	5342300	Till "B"	Mv	91HJ452	656000	5327700	R-Till Peb	Fi
91HJ408	683400	5342300	Till Peb	Mv	91HJ453	662300	5319400	Till "B"	Fi
91HJ409	682400	5340800	Till "B"	Mv	91HJ454	662300	5319400	Till Peb	Fi
91HJ410	682400	5340800	Till Peb	Mv	91HJ455	661800	5318600	Till "B"	Fi
91HJ411	682500	5338600	Till "B"	Mv	91HJ456	661800	5328900	Till Peb	Fi
91HJ412	682500	5338600	Till Peb	Mv	91HJ459	666000	5343000	Till "B"	Mv
91HJ413	684500	5338700	Till "B"	Mv	91HJ460	666000	5343000	Till Peb	Mv
91HJ414	684500	5338700	Till Peb	Mv	91HJ461	663200	5344400	Till "B"	Ms
91HJ415	684200	5336400	Till "B"	Fi	91HJ462	663200	5344400	Till Peb	Ms
91HJ416	684200	5336400	Till Peb	Fi	91HJ463	659400	5344800	Till "B"	Mv
91HJ417	683600	5333200	Till "B"	Fi	91HJ464	659400	5344800	Till Peb	Mv
91HJ418	683600	5333200	Till Peb	Fi	91HJ465	649700	5333500	R-Till "B"	Fi

APPENDIX A: Sample Site Locations (Continued)

Sample No.	U.T.M.		Material	Terrane	Sample No.	U.T.M.		Material	Terrane
	Easting	Northing				Easting	Northing		
91HJ466	649700	5333500	R-Till Peb	Fi	91F511	718900	5356000	Ow Peb	Fi
91HJ467	653200	5333900	R-Till "B"	Fi	91F513	716600	5350600	Ow	Fi
91HJ468	653200	5333900	R-Till Peb	Fi	91F513	716600	5350600	Ow Peb	Fi
91HJ469	655200	5332300	Till "B"	Fi	91ML515	717200	5346800	Ow	Fi
91HJ470	655200	5332300	Till Peb	Fi	91ML515	717200	5346800	Ow Peb	Fi
91HJ471	659500	5335500	R-Till "B"	Mv	91ML517	716800	5339000	Ow	Mv
91HJ472	659500	5335500	R-Till Peb	Mv	91ML517	716800	5339000	Ow Peb	Mv
91HJ473	662800	5328900	Till "B"	Fv	91ML519	719200	5337200	Ow	Mv
91HJ474	662800	5328900	Till Peb	Fv	91ML519	719200	5337200	Ow Peb	Mv
91HJ475	666200	5327300	Till "B"	Fv	91ML521	719300	5334500	Ow	Fi
91HJ476	666200	5327300	Till Peb	Fv	91ML521	719300	5334500	Ow Peb	Fi
91HJ477	662400	5324400	Till "B"	Mv	91F522	688300	5350700	Ow	Mv
91HJ478	662400	5324400	Till Peb	Mv	91F523	688300	5350700	Ow	Mv
91HJ479	661700	5323700	Till "B"	Mv	91F523	688300	5350700	Ow Peb	Mv
91HJ480	661700	5323700	Till Peb	Mv	91F525	689900	5351600	Ow	Fv
91HJ481	682300	5323500	R-Till "B"	Fi	91F525	689900	5351600	Ow Peb	Fv
91HJ482	682300	5323500	R-Till Peb	Fi	91F527	693700	5354000	Ow	Mv
91HJ483	685800	5328600	Till "B"	Fi	91F527	693700	5354000	Ow Peb	Mv
91HJ484	685800	5328600	Till Peb	Fi	91F528	696500	5352300	Eolian	Mv
91HJ485	685800	5328600	Till "A"	Fi	91F529	695500	5352300	Eolian	Mv
91HJ486	684500	5328300	Till "B"	Fi	91F530	695400	5354600	Ma	Mv
91HJ487	684500	5328300	Till Peb	Fi	91F531	695400	5354600	Ow	Mv
91HJ488	681100	5328500	R-Till "B"	Fi	91F531	695400	5354600	Ow Peb	Mv
91HJ489	681100	5328500	R-Till Peb	Fi	91F532	697200	5356000	Ma	Mv
91HJ490	681000	5325200	R-Till "B"	Fi	91F533	697200	5356000	Ow	Mv
91HJ491	681000	5325200	R-Till Peb	Fi	91F533	697200	5356000	Ow Peb	Mv
91HJ492	678200	5325800	R-Till "B"	Mv	91F534	696100	5356100	Ma	Mi
91HJ493	678200	5325800	R-Till Peb	Mv	91F535	696100	5356100	Ow	Mi
91HJ494	677000	5324000	Till "B"	Mv	91F535	696100	5356100	Ow Peb	Mi
91HJ495	677000	5324000	Till Peb	Mv	91F538	690600	5359700	Ow	Fi
91HJ496	674100	5322000	Till "B"	Mv	91F538	690600	5359700	Ow Peb	Fi
91HJ497	674100	5322000	Till Peb	Mv	Wad1P94	671200	5325800	Ma	Mv
91HJ498	674400	5328100	Till "B"	Fv	Wad2P94	673000	5322500	Ma	Mv
91HJ499	674400	5328100	Till Peb	Fv	Wad4P94	669600	5325400	Ma	Ms
91HJ500	671500	5325200	Till "B"	Mv	Wad5P94	669300	5327500	Ma	Mv
91HJ501	671500	5325200	Till Peb	Mv	Wad6P94	667000	5327700	Ma	Fv
91HJ502	672500	5322700	Till "B"	Fv	Wad7P94	663900	5326800	Ma	Mv
91HJ503	672500	5322700	Till Peb	Fv	Wad9P94	689600	5358800	Ma	Fi
91HJ504	667800	5320600	Till "B"	Fv	Wad10P94	691800	5359900	Ma	Fi
91HJ505	667800	5320600	Till Peb	Fv	Wad11P94	694400	5358300	Ma	Ms
91HJ506	665800	5319000	Till "B"	Fv	Wad12P94	697400	5355800	Ma	Mv
91HJ507	665800	5319000	Till Peb	Fv	Wad13P94	702000	5358900	Ma	Mv
91F509	721600	5359100	Ow	Fv	Wad16P94	687400	5354300	Ma	Ai
91F509	721600	5359100	Ow Peb	Fv	Wad17P94	690050	5351500	Ma	Fv
91F511	718900	5356000	Ow	Fi	Wad19P94	692900	5349900	Ma	Fv

APPENDIX A: Sample Site Locations (Continued)

Sample No.	U.T.M.		Material	Terrane	Sample No.	U.T.M.		Material	Terrane
	Easting	Northing				Easting	Northing		
Wad21P94	683500	5345800	Ma	Fv	Wad73P94	663600	5311600	Ma	Mv
Wad22P94	692700	5346700	Ma	Mv	Wad74P94	660700	5308900	Ma	Mv
Wad23P94	693050	5346100	Ma	Mv	Wad76P94	673600	5308000	Ma	Fi
Wad24P94	690100	5340500	Ma	Mv	Wad77P94	673500	5308400	Ma	Fi
Wad26P94	693400	5343400	Ma	Mv	Wad78P94	668500	5311800	Ma	Fv
Wad27P94	695300	5344600	Ma	Mv	Wad79P94	672500	5313800	Ma	Fv
Wad28P94	700900	5348400	Ma	Ai	Wad80P94	664800	5330000	Ma	Mv
Wad29P94	654400	5324300	Ma	Fi	Wad82P94	662400	5321600	Ma	Ms
Wad30P94	652700	5323600	Ma	Fi	Wad83P94	664000	5316800	Ma	Mv
Wad32P94	650300	5321700	Ma	Fi	Wad85P94	663100	5307350	Ma	Mv
Wad33P94	651400	5325200	Ma	Fi	Wad86P94	682700	5310100	Ma	Fi
Wad34P94	653100	5329000	Ma	Fi	Wad87P94	680900	5310400	Ma	Fi
Wad35P94	653500	5330800	Ma	Fi	Wad88P94	680700	5309500	Ma	Fi
Wad36P94	654200	5326500	Ma	Fi	Wad89P94	678600	5309700	Ma	Fi
Wad37P94	651200	5333200	Ma	Fi	Wad90P94	678500	5309100	Ma	Fi
Wad39P94	651200	5331800	Ma	Fi	Wad91P94	677700	5309500	Ma	Fi
Wad40P94	655700	5331900	Ma	Fi	Wad92P94	676700	5308100	Ma	Fi
Wad41P94	652000	5332900	Ma	Fi	Wad93P94	675900	5308500	Ma	Fi
Wad42P94	659700	5335800	Ma	Mv	Wad94P94	684100	5316600	Ma	Fi
Wad43P94	661700	5337400	Ma	Ms	Wad95P94	684200	5313800	Ma	Fi
Wad44P94	659800	5341500	Ma	Mv	Wad97P94	684500	5312100	Ma	Fi
Wad46P94	670300	5340800	Ma	Fv	Wad98P94	683900	5309800	Ma	Fi
Wad47P94	666800	5343500	Ma	Mv	Wad99P94	684200	5308400	Ma	Fi
Wad48P94	663100	5344200	Ma	Ms	Wad100P94	682700	5308900	Ma	Fi
Wad49P94	661800	5344100	Ma	Mv	Wad101P94	681500	5306200	Ma	Fi
Wad50P94	662700	5335800	Ma	Ms	Wad103P94	680200	5346200	Ma	Mv
Wad51P94	654600	5343100	Ma	Fv	Wad104P94	687000	5339000	Ma	Mv
Wad53P94	662900	5332700	Ma	Mv	Wad106P94	682900	5341200	Ma	Mv
Wad54P94	662900	5330600	Ma	Fv	Wad107P94	683400	5342600	Ma	Fv
Wad55P94	662000	5326400	Ma	Fv	Wad108P94	683400	5335700	Ma	Fi
Wad56P94	675200	5322300	Ma	Mv	Wad109P94	659800	5306900	Ma	Mv
Wad57P94	675400	5319300	Ma	Mv	Wat200P94	718900	5333300	Ma	Fi
Wad58P94	675050	5317500	Ma	Mv	Wat201P94	719500	5334800	Ma	Fi
Wad59P94	673400	5315400	Ma	Mv	Wat202P94	719700	5336500	Ma	Fi
Wad60P94	673600	5315500	Ma	Mv	Wat204P94	717100	5338900	Ma	Mv
Wad61P94	672500	5310900	Ma	Mv	Wat205P94	719800	5338300	Ma	Fi
Wad63P94	671900	5308900	Ma	Fi	Wat207P94	681400	5328800	Ma	Fi
Wad64P94	667600	5308500	Ma	Mv	Wat208P94	681800	5331800	Ma	Fi
Wad65P94	666300	5308400	Ma	Mv	Wat209P94	682800	5331500	Ma	Fi
Wad66P94	664200	5309400	Ma	Fi	Wat210P94	683800	5332200	Ma	Fi
Wad67P94	663600	5309300	Ma	Mv	Wat212P94	682500	5338700	Ma	Mv
Wad68P94	661100	5310500	Ma	Mv	Wat213P94	683600	5335100	Ma	Fi
Wad70P94	662050	5311800	Ma	Mv	Wat214P94	654500	5327900	Ma	Fi
Wad71P94	659500	5314200	Ma	Mv	Wat215P94	655600	5326800	Ma	Fi
Wad72P94	660300	5313600	Ma	Mv	Wat216P94	655600	5325700	Ma	Fi

APPENDIX A: Sample Site Locations (Continued)

Sample No.	U.T.M.		Material	Terrane	Sample No.	U.T.M.		Material	Terrane
	Easting	Northing				Easting	Northing		
Wat218P94	656500	5323000	Ma	Fi	Wat275P94	672800	5341900	Ma	Mv
Wat219P94	657100	5322000	Ma	Ms	Wat276P94	671100	5336600	Ma	Ms
Wat220P94	658800	5320600	Ma	Ms	Wat277P94	668900	5334800	Ma	Mv
Wat221P94	715100	5356600	Ma	Fi	Wat278P94	668000	5332300	Ma	Mv
Wat223P94	714300	5356900	Ma	Fi	Wat281P94	663500	5322800	Ma	Ms
Wat225P94	708800	5360100	Ma	Ms	Wat282P94	665900	5323500	Ma	Fv
Wat227P94	708900	5356000	Ma	Mv	Wat283P94	667600	5324100	Ma	Ms
Wat228P94	709000	5352800	Ma	Mv	Wat285P94	668400	5324200	Ma	Ms
Wat229P94	707500	5349800	Ma	Mv	Wat286P94	612500	5342600	Ma	Fi
Wat230P94	706800	5348100	Ma	Mv	Wat287P94	613900	5346000	Ma	Fi
Wat231P94	709600	5348700	Ma	Fi	Wat288P94	611600	5334100	Ma	Mv
Wat232P94	712200	5349900	Ma	Fi	Wat289P94	614700	5338300	Ma	Mv
Wat233P94	712900	5351300	Ma	Fi	Wat291P94	620900	5336500	Ma	Fi
Wat234P94	715200	5351400	Ma	Fi	Wat292P94	674500	5328400	Ma	Fv
Wat235P94	719600	5350900	Ma	Fi	Wat293H94	660700	5307300	Humus	Mv
Wat236P94	720700	5351100	Ma	Mv	Wat293B94	660700	5307300	Till "B"	Mv
Wat238P94	717100	5352800	Ma	Mv	Wat293C94	660700	5307300	Till "C"	Mv
Wat239P94	708200	5342900	Ma	Mv	Wat293Tm94	660700	5307300	Till Bulk	Mv
Wat241P94	721100	5358800	Ma	If	Wat294H94	663900	5311200	Humus	Mv
Wat244P94	710800	5343200	Ma	Fi	Wat294B94	663900	5311200	Till "B"	Mv
Wat246P94	713900	5346000	Ma	Fi	Wat294C94	663900	5311200	Till "C"	Mv
Wat247P94	714800	5347600	Ma	Fi	Wat294Tm94	663900	5311200	Till Bulk	Mv
Wat248P94	718500	5345800	Ma	Mv	Wat295H94	657100	5314400	Humus	Mv
Wat251P94	704000	5344800	Ma	Mv	Wat295B94	657100	5314400	Till "B"	Mv
Wat252P94	703500	5343700	Ma	Mv	Wat295B94	657100	5314400	Till "C"	Mv
Wat253P94	700800	5341900	Ma	Mv	Wat295Tm94	657100	5314400	Till Bulk	Mv
Wat254P94	700500	5341700	Ma	Mv	Wat296H94	682900	5306200	Humus	Fi
Wat255P94	699500	5342800	Ma	Mv	Wat296B94	682900	5306200	Till "B"	Fi
Wat256P94	666800	5317400	Ma	Fv	Wat296C94	682900	5306200	Till "C"	Fi
Wat257P94	669000	5318200	Ma	Fv	Wat296Tm94	682900	5306200	Till Bulk	Fi
Wat258P94	668000	5314700	Ma	Fv	Wat297H94	685000	5312100	Humus	Fi
Wat259P94	669300	5314800	Ma	Fv	Wat297B94	685000	5312100	Till "B"	Fi
Wat260P94	668600	5313200	Ma	Fv	Wat297C94	685000	5312100	Till "C"	Fi
Wat261P94	695000	5339800	Ma	Mv	Wat297Tm94	685000	5312100	Till Bulk	Fi
Wat262P94	698400	5341900	Ma	Mv	Wat298H94	685200	5316900	Humus	Fi
Wat263P94	700400	5339800	Ma	Mv	Wat298B94	685200	5316900	Till "B"	Fi
Wat264P94	699300	5338900	Ma	Fi	Wat298C94	685200	5316900	Till "C"	Fi
Wat265P94	696900	5338000	Ma	Fi	Wat298Tm94	685200	5316900	Till Bulk	Fi
Wat266P94	696100	5337200	Ma	Fi	Wat299H94	683200	5316600	Humus	Fi
Wat267P94	660200	5316400	Ma	Fi	Wat299B94	683200	5316600	Till "B"	Fi
Wat268P94	692700	5337500	Ma	Fi	Wat299C94	683200	5316600	Till "C"	Fi
Wat269P94	693300	5334300	Ma	Fi	Wat299Tm94	683200	5316600	Till Bulk	Fi
Wat270P94	696900	5332400	Ma	Fi	Wat300H94	675100	5317100	Humus	Fi
Wat271P94	683800	5319600	Ma	Fi	Wat300B94	675100	5317100	Till "B"	Fi
Wat273P94	674200	5344600	Ma	Mv	Wat300C94	675100	5317100	Till "C"	Fi

APPENDIX A: Sample Site Locations (Continued)

Sample No.	U.T.M.		Material	Terrane	Sample No.	U.T.M.		Material	Terrane
	Easting	Northing				Easting	Northing		
Wat300Tm94	675100	5317100	Till Bulk	Fi	Wat338MAP94	663200	5309100	Ma	Mv
Wat301H94	673400	5316300	Humus	Fv	Wat341MAP94	662100	5309500	Ma	Mv
Wat301B94	673400	5316300	Till "B"	Fv	Wat342MAP94	662300	5311400	Ma	Mv
Wat301C94	673400	5316300	Till "C"	Fv	Wat348MAP94	663700	5312700	Ma	Mv
Wat301Tm94	673400	5316300	Till Bulk	Fv	Wat349MAP94	665300	5313700	Ma	Fv
Wat302H94	673200	5313300	Humus	Fv	Wat350MAP94	665800	5315000	Ma	Fv
Wat302B94	673200	5313300	Till "B"	Fv	Wat351MAP94	665800	5315100	Ma	Fv
Wat302C94	673200	5313300	Till "C"	Fv	Wat352MAP94	666100	5316100	Ma	Fv
Wat302Tm94	673200	5313300	Till Bulk	Fv	Wat353MAP94	666000	5316000	Ma	Fv
Wat303H94	668400	5317600	Humus	Fv	Waj314MAP94	665900	5313600	Ma	Fv
Wat303B94	668400	5317600	Till "B"	Fv	Waj315MAP94	666300	5313700	Ma	Fv
Wat303C94	668400	5317600	Till "C"	Fv	Waj316MAP94	666600	5313900	Ma	Fv
Wat303Tm94	668400	5317600	Till Bulk	Fv	Waj317MAP94	667200	5314200	Ma	Fv
Wat304P94	670000	5314900	Ma	Fv	Waj318MAP94	667200	5314200	Ma	Fv
Wat305H94	668200	5312300	Humus	Fv	Waj319MAP94	667200	5314200	Ma	Fv
Wat305B94	668200	5312300	Till "B"	Fv	Waj320MAP94	667800	5314300	Ma	Fv
Wat305C94	668200	5312300	Till "C"	Fv	Waj321MAP94	668900	5314700	Ma	Fv
Wat305Tm94	668200	5312300	Till Bulk	Fv	Waj322MAP94	665800	5312800	Ma	Fv
Wat306H94	680200	5310200	Humus	Fi	Waj323MAP94	666100	5312500	Ma	Fv
Wat306B94	680200	5310200	Till "B"	Fi	Waj324MAP94	665900	5312400	Ma	Fv
Wat306C94	680200	5310200	Till "C"	Fi	Waj325MAP94	665400	5311600	Ma	Mv
Wat306Tm94	680200	5310200	Till Bulk	Fi	Waj326MAP94	665200	5311500	Ma	Mv
Wat307H94	677400	5309400	Humus	Fi	Waj328MAP94	665400	5310300	Ma	Mv
Wat307B94	677400	5309400	Till "B"	Fi	Waj329MAP94	665400	5310300	Ma	Mv
Wat307C94	677400	5309400	Till "C"	Fi	Waj330MAP94	665400	5310300	Ma	Mv
Wat307Tm94	677400	5309400	Till Bulk	Fi	Waj331MAP94	666400	5311600	Ma	Fv
Wat308H94	676300	5308000	Humus	Fi	Waj332MAP94	666500	5311500	Ma	Fv
Wat308B94	676300	5308000	Till "B"	Fi	Waj333MAP94	667400	5311800	Ma	Fv
Wat308C94	676300	5308000	Till "C"	Fi	1-Ma-96	701900	5315500	Ma	Mg
Wat308Tm94	676300	5308000	Till Bulk	Fi	2-TH-96	704650	5313900	Till Humus	Fi
Wat309H94	670900	5308000	Humus	Fi	2-TB-96	704650	5313900	Till "B"	Fi
Wat309B94	670900	5308000	Till "B"	Fi	2-TC-96	704650	5313900	Till "C"	Fi
Wat309C94	670900	5308000	Till "C"	Fi	2-TM-96	704650	5313900	Till Bulk	Fi
Wat309Tm94	670900	5308000	Till Bulk	Fi	5-Ma-96	718123	5330447	Ma	Fi
Wat310P94	664300	5310900	Ma	Mv	6-Ma-96	718399	5328317	Ma	Fi
Wat311P94	657600	5314300	Ma	Mv	7-TH-96	718145	5327826	Humus	Fi
Wat311Tm94	657600	5314300	Till Bulk	Mv	7-TB-96	718145	5327826	Till "B"	Fi
Wat312H94	660000	5314100	Humus	Mv	7-TC-96	718145	5327826	Till "C"	Fi
Wat312B94	660000	5314100	Till "B"	Mv	7-TM-96	718145	5327826	Till Bulk	Fi
Wat312C94	660000	5314100	Till "C"	Mv	8-Ma-96	715555	5325219	Ma	Fi
Wat312Tm94	660000	5314100	Till Bulk	Mv	9-TH-96	714967	5324406	Humus	Fi
Wat313MAP94	660300	5313500	Ma	Mv	9-TB-96	714967	5324406	Till "B"	Fi
Wat335MAP94	666400	5309100	Ma	Mv	9-TC-96	714967	5324406	Till "C"	Fi
Wat336MAP94	665400	5310300	Ma	Mv	9-TM-96	714967	5324406	Till Bulk	Fi
Wat337MAP94	664900	5309200	Ma	Mv	10-Ma-96	714137	5322458	Ma	Fi

APPENDIX A: Sample Site Locations (Continued)

Sample No.	U.T.M.		Material	Terrane	Sample No.	U.T.M.		Material	Terrane
	Easting	Northing				Easting	Northing		
11-Ma-96	714950	5322100	Ma	Fi	44-TH-96	715366	5313608	Humus	Fi
12-Ma-96	716650	5322200	Ma	Fi	44-TB-96	715366	5313608	Till "B"	Fi
13-Ma-96	715050	5320750	Ma	Mg	44-TC-96	715366	5313608	Till "C"	Fi
14-Ma-96	716000	5317650	Ma	Fi	44-TM-96	715366	5313608	Till Bulk	Fi
15-TH-96	714776	5318198	Humus	Fi	44-TP-96	715366	5313608	Till Peb	Fi
15-TB-96	714776	5318198	Till "B"	Fi	45-TH-96	689367	5313385	Humus	Fi
15-TC-96	714776	5318198	Till "C"	Fi	45-TB-96	689367	5313385	Till "B"	Fi
15-Tm-96	714776	5318198	Till Bulk	Fi	45-TC-96	689367	5313385	Till "C"	Fi
16-Ma-96	690549	5322196	Ma	Fi	45-TM-96	689367	5313385	Till Bulk	Fi
17-Ma-96	689987	5321975	Ma	Fi	45-TP-96	689367	5313385	Till Peb	Fi
18-Ma-96	691225	5328400	Ma	Fi	46-Ma-96	716731	5320973	Ma	Fi
19-Ma-96	691975	5328125	Ma	Fi	47-Ma-96	716731	5320973	Ma	Fi
20-Ma-96	691745	5326885	Ma	Fi	48-Es-96	711621	5327283	Es	Fi
21-Ma-96	692300	5327000	Ma	Fi	49-TH-96	711813	5329028	Humus	Fi
22-Ma-96	715800	5330350	Ma	Fi	49-TB-96	711813	5329028	Till "B"	Fi
23-Ma-96	715900	5331850	Ma	Fi	49-TC-96	711813	5329028	Till "C"	Fi
24-Ma-96	716200	5332200	Ma	Fi	49-TM-96	711813	5329028	Till Bulk	Fi
25-Ma-96	716500	5331800	Ma	Fi	49-TP-96	711813	5329028	Till Peb	Fi
26-Ma-96	713400	5312578	Ma	Fi	50-Ma-96	712994	5330015	Ma	Fi
27-Ma-96	711313	5327449	Ma	Fi	51-Ma-96	712925	5330700	Ma	Fi
28-Ma-96	710608	5329770	Ma	Fi	52-Es-96	716744	5321499	Es	Fi
29-Ma-96	710106	5329527	Ma	Fi	53-Ma-96	718300	5321500	Ma	Fi
30-Ma-96	715348	5314088	Ma	Fi	54-Ma-96	714350	5331000	Ma	Fi
31-Ma-96	704237	5327102	Ma	Fi	55-Ma-96	715665	5330708	Ma	Fi
32-TH-96	704355	5327342	Humus	Fi	56-Ma-96	717026	5332374	Ma	Fi
32-TB-96	704355	5327342	Till "B"	Fi	57-Ma-96	721650	5332800	Ma	Fi
32-TC-96	704355	5327342	Till "C"	Fi	58a-Ma-96	715000	5321875	Ma	Fi
32-TM-96	704355	5327342	Till Bulk	Fi	58b-Tm-96	723550	5315200	Till Bulk	Fi
32-TP-96	704355	5327342	Till Peb	Fi	58b-TP-96	723550	5315200	Till Peb	Fi
33-Ma-96	705429	5316991	Ma	Fi	59-Ma-96	723350	5319625	Ma	Fi
34-Ma-96	707848	5327937	Ma	Fi	60-TH-96	723250	5319925	Humus	Fi
35-Ma-96	721455	5334410	Ma	Fi	60-TB-96	723250	5319925	Till "B"	Fi
36-Ma-96	708367	5328054	Ma	Fi	60-TC-96	723250	5319925	Till "C"	Fi
37-TH-96	708374	5328712	Humus	Fi	60-TM-96	723250	5319925	Till Bulk	Fi
37-TM-96	708374	5328712	Till Bulk	Fi	60-TP-96	723250	5319925	Till Peb	Fi
37-TP-96	708374	5328712	Till Peb	Fi	61-TH-96	719387	5319500	Humus	Fi
39-Ma-96	712418	5314222	Ma	Fi	61-TB-96	719387	5319500	Till "B"	Fi
40-Ma-96	695855	5313163	Ma	Mg	61-TC-96	719387	5319500	Till "C"	Fi
41-Ma-96	696498	5314902	Ma	Mg	61-TM-96	719387	5319500	Till Bulk	Fi
42-Ma-96	721325	5313410	Ma	Fi	61-TP-96	719387	5319500	Till Peb	Fi
43-TH-96	721277	5313174	Humus	Fi	62-Ma-96	712500	5317550	Ma	Fi
43-TB-96	721277	5313174	Till "B"	Fi	63-Ma-96	707508	5318889	Ma	Mg
43-TC-96	721277	5313174	Till "C"	Fi	64-TH-96	707250	5318825	Humus	Fi
43-TM-96	721277	5313174	Till Bulk	Fi	64-TB-96	707250	5318825	Till "B"	Fi
43-TP-96	721277	5313174	Till Peb	Fi	64-TC-96	707250	5318825	Till "C"	Fi

APPENDIX A: Sample Site Locations (Continued)

Sample No.	U.T.M.		Material	Terrane	Sample No.	U.T.M.		Material	Terrane
	Easting	Northing				Easting	Northing		
64-TM-96	707250	5318825	Till Bulk	Fi	1027-TH-96	701800	5325200	Humus	Fi
64-TP-96	707250	5318825	Till Peb	Fi	1027-TB-96	701800	5325200	Till "B"	Fi
66-TH-96	717588	5322253	Humus	Fi	1027-TC-96	701800	5325200	Till "C"	Fi
66-TB-96	717588	5322253	Till "B"	Fi	1027-TM-96	701800	5325200	Till Bulk	Fi
66-TC-96	717588	5322253	Till "C"	Fi	1027-TP-96	701800	5325200	Till Peb	Fi
66-TM-96	717588	5322253	Till Bulk	Fi	1028-GFS-96	701090	5325624	C-Gl	Fi
66-TP-96	717588	5322253	Till Peb	Fi	1029-Ma-96	700699	5325605	Ma	Fi
1001-Ma-96	723514	5308492	Ma	Fi	1030-GFS-96	700421	5325175	C-Gl	Fi
1002-TH-96	723006	5308549	Humus	Fi	1031-Ma-96	699778	5324938	Ma	Fi
1002-TB-96	723006	5308549	Till "B"	Fi	1032-Ma-96	699960	5324689	Ma	Fi
1002-TC 96	723006	5308549	Till "C"	Fi	1033-Ma-96	690788	5302773	Ma	Fi
1002-TM-96	723006	5308549	Till Bulk	Fi	1034-Ma-96	689520	5305431	Ma	Fi
1002-TP-96	723006	5308549	Till Peb	Fi	1035-Ma-96	689483	5308249	Ma	Fi
1003-Ma-96	720493	5308981	Ma	Fi	1036-TH-96	689557	5308772	Humus	Fi
1004-Ma-96	722303	5310435	Ma	Fi	1036-TB-96	689557	5308772	Till "B"	Fi
1005-Ma-96	721934	5310655	Ma	Fi	1036-TC-96	689557	5308772	Till "C"	Fi
1006-Ma-96	720013	5306765	Ma	Fi	1036-TM-96	689557	5308772	Till Bulk	Fi
1007-Ma-96	719527	5303764	Ma	Fi	1036-TP-96	689557	5308772	Till Peb	Fi
1008-Ma-96	719152	5305044	Ma	Fi	1037-Ma-96	688476	5310222	Ma	Fi
1009-TH-96	720462	5306941	Humus	Fi	1038-Ma-96	698433	5324408	Ma	Fi
1009-TB-96	720462	5306941	Till "B"	Fi	1039-Ma-96	698380	5324300	Ma	Fi
1009-TC-96	720462	5306941	Till "C"	Fi	1040-TH-96	698506	5323340	Humus	Fi
1009-TM-96	720462	5306941	Till Bulk	Fi	1040-TB-96	698506	5323340	Till "B"	Fi
1009-TP-96	720462	5306941	Till Peb	Fi	1040-TC-96	698506	5323340	Till "C"	Fi
1010-Ma-96	711209	5310049	Ma	Fi	1040-TM-96	698506	5323340	Till Bulk	Fi
1011-Ma-96	712649	5310013	Ma	Fi	1040-TP-96	698506	5323340	Till Peb	Fi
1012-Ma-96	712387	5307950	Ma	Fi	1041-Ma-96	698200	5323950	Ma	Fi
1013-Ma-96	714510	5309487	Ma	Fi	1042-Ma-96	697450	5321912	Ma	Fi
1014-TH-96	715149	5307790	Humus	Fi	1043-Ma-96	697803	5321056	Ma	Fi
1014-TB-96	715149	5307790	Till "B"	Fi	1044-Ma-96	694901	5304529	Ma	Fi
1014-TC-96	715149	5307790	Till "C"	Fi	1045-Ma-96	696852	5306245	Ma	Fi
1014-TM-96	715149	5307790	Till Bulk	Fi	1046-Ma-96	688426	5312191	Ma	Fi
1014-TP-96	715149	5307790	Till Peb	Fi	1047-Ma-96	696065	5319558	Ma	Fi
1015-Ma-96	714826	5307944	Ma	Fi	1048-Ma-96	695339	5320345	Ma	Fi
1016-Ma-96	713711	5305159	Ma	Fi	1050-Ma-96	693249	5319038	Ma	Fi
1017-Ma-96	715847	5304373	Ma	Fi	1051-Ma-96	703404	5308720	Ma	Fi
1018-Ma-96	716486	5304980	Ma	Fi	1052-Ma-96	704400	5309100	Ma	Fi
1019-Ma-96	717556	5304776	Ma	Fi	1054-TH-96	704600	5310503	Humus	Fi
1020-Ma-96	720605	5307707	Ma	Fi	1054-TB-96	704600	5310503	Till "B"	Fi
1021-Ma-96	698838	5308611	Ma	Fi	1054-TC-96	704600	5310503	Till "C"	Fi
1022-Ma-96	699900	5309950	Ma	Fi	1054-TM-96	704600	5310503	Till Bulk	Fi
1023-Ma-96	700115	5311107	Ma	Fi	1054-TP-96	704600	5310503	Till Peb	Fi
1024-Ma-96	700981	5313600	Ma	Mg	1057-Ma-96	696147	5215259	Ma	Fi
1025-Ma-96	702074	5325962	Ma	Fi	1058-Ma-96	698003	5317411	Ma	Fi
1026-Ma-96	701686	5325567	Ma	Fi	1059-TH-96	698078	5318096	Humus	Fi

APPENDIX A: Sample Site Locations (Continued)

Sample No.	U.T.M.		Material	Terrane	Sample No.	U.T.M.		Material	Terrane
	Easting	Northing				Easting	Northing		
1059-TB-96	698078	5318096	Till "B"	Fi	1083-Ma-96	703636	5320707	Ma	Fi
1059-TC-96	698078	5318096	Till "C"	Fi	1084-TH-96	701900	5319700	Humus	Fi
1059-TM-96	698078	5318096	Till Bulk	Fi	1084-TB-96	701900	5319700	Till "B"	Fi
1059-TP-96	698078	5318096	Till Peb	Fi	1084-TC-96	701900	5319700	Till "C"	Fi
1061-Ma-96	704309	5318368	Ma	Fi	1084-TM-96	701900	5319700	Till Bulk	Fi
1062-Ma-96	704109	5318746	Ma	Fi	1084-TP-96	701900	5319700	Till Peb	Fi
1064-Ma-96	704150	5319007	Ma	Fi	1085-Ma-96	700481	5318937	Ma	Fi
1065-Ma-96	699160	5319795	Ma	Fi	1086-Ma-96	699124	5319591	Ma	Fi
1066-Ma-96	687382	5328198	Ma	Fi	1087-Ma-96	707473	5321375	Ma	Fi
1067-TH-96	688001	5329126	Humus	Fi	1088-Ma-96	707900	5321500	Ma	Fi
1067-TB-96	688001	5329126	Till "B"	Fi	1089-Ma-96	707900	5321500	Ma	Fi
1067-TC-96	688001	5329126	Till "C"	Fi	1090-Ma-96	708156	5323672	Ma	Fi
1067-TM-96	688001	5329126	Till Bulk	Fi	1091-TH-96	693572	5317408	Humus	Fi
1067-TP-96	688001	5329126	Till Peb	Fi	1091-TB-96	693572	5317408	Till "B"	Fi
1068-Ma-96	694200	5331800	Ma	Fi	1091-TC-96	693572	5317408	Till "C"	Fi
1069-Ma-96	692300	5330169	Ma	Fi	1091-TM-96	693572	5317408	Till Bulk	Fi
1070-TH-96	692250	5329975	Humus	Fi	1091-TP-96	693572	5317408	Till Peb	Fi
1070-TB-96	692250	5329975	Till "B"	Fi	1092-Ma-96	693379	5317482	Ma	Fi
1070-TC-96	692250	5329975	Till "C"	Fi	1093-Ma-96	692088	5315468	Ma	Fi
1070-TM-96	692250	5329975	Till Bulk	Fi	1094-Ma-96	690435	5314546	Ma	Mv
1070-TP-96	692250	5329975	Till Peb	Fi	1096-Ma-96	708100	5322700	Ma	Fi
1071-Ma-96	690284	5330375	Ma	Fi	1097-Ma-96	708400	5324200	Ma	Fi
1072-Lac-96	709407	5309650	F-Gl	Fi	1098-Ma-96	708950	5324250	Ma	Fi
1073-TH-96	709638	5310801	Humus	Fi	1099-Ma-96	710235	5325880	Ma	Fi
1073-TB-96	709638	5310801	Till "B"	Fi	1100-Ma-96	710531	5325394	Ma	Fi
1073-TC-96	709638	5310801	Till "C"	Fi	1101-Ma-96	710980	5326604	Ma	Fi
1073-TM-96	709638	5310801	Till Bulk	Fi	1102-Ma-96	691030	5312352	Ma	Fi
1073-TP-96	709638	5310801	Till Peb	Fi	1103-TH-96	692700	5325700	Humus	Fi
1074-TH-96	704600	5315400	Humus	Fi	1103-TB-96	692700	5325700	Till "B"	Fi
1074-TB-96	704600	5315400	Till "B"	Fi	1103-TC-96	692700	5325700	Till "C"	Fi
1074-TC-96	704600	5315400	Till "C"	Fi	1103-TM-96	692700	5325700	Till Bulk	Fi
1074-TM-96	704600	5315400	Till Bulk	Fi	1103-TP-96	692700	5325700	Till Peb	Fi
1074-TP-96	704600	5315400	Till Peb	Fi	1104-Ma-96	692449	5324915	Ma	Fi
1075-Ma-96	705178	5311384	Ma	Fi	1105-TH-96	689200	5323900	Humus	Fi
1076-Ma-96	703898	5314446	Ma	Fi	1105-TB-96	689200	5323900	Till "B"	Fi
1077-Ma-96	690300	5329300	Ma	Fi	1105-TC-96	689200	5323900	Till "C"	Fi
1078-Ma-96	692000	5329900	Ma	Fi	1105-TM-96	689200	5323900	Till Bulk	Fi
1079-Ma-96	693313	5326085	Ma	Fi	1105-TP-96	689200	5323900	Till Peb	Fi
1080-Ma-96	701078	5314158	Ma	Mg	1106-Ma-96	687929	5321289	Ma	Fi
1081-TH-96	700943	5314397	Humus	Fi	1107-Ma-96	690551	5320828	Ma	Fi
1081-TB-96	700943	5314397	Till "B"	Fi	1108-Ma-96	688700	5317800	Ma	Fi
1081-TC-96	700943	5314397	Till "C"	Fi	1109-Ma-96	688300	5319000	Ma	Fi
1081-TM-96	700943	5314397	Till Bulk	Fi	1110-Ma-96	687900	5326300	Ma	Fi
1081-Tp-96	700943	5314397	Till Peb	Fi	1111-Ma-96	693200	5322400	Ma	Fi
1082-Ma-96	697352	5315629	Ma	Fi	1112-Ma-96	692400	5324900	Ma	Fi

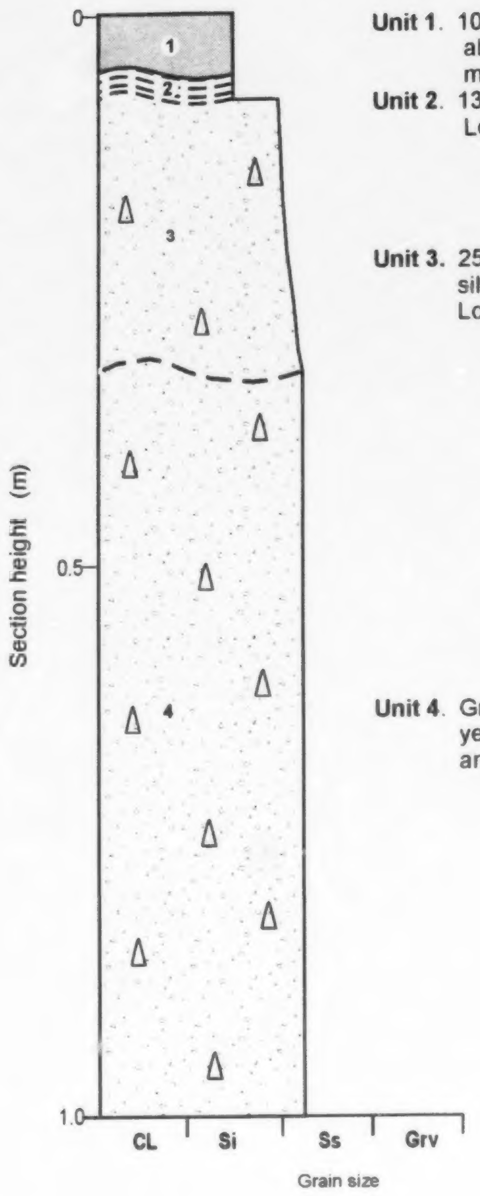
APPENDIX A: Sample Site Locations (Continued)

Sample No.	U.T.M.		Material	Terrane	Sample No.	U.T.M.		Material	Terrane
	Easting	Northing				Easting	Northing		
1113-Ma-96	697900	5326100	Ma	Fi	1126-TC-96	723250	5319800	Till "C"	Fi
1114-TH-96	697400	5328900	Humus	Fi	1126-TM-96	723250	5319800	Till Bulk	Fi
1114-TB-96	697400	5328900	Till "B"	Fi	1126-TP-96	723250	5319800	Till Peb	Fi
1114-TC-96	697400	5328900	Till "C"	Fi	1127-Ma-96	723100	5329700	Ma	Fi
1114-TM-96	697400	5328900	Till Bulk	Fi	1128-Ma-96	720150	5324900	Ma	Fi
1114-TP-96	697400	5328900	Till Peb	Fi	1132-TH-96	687400	5318200	Humus	Fi
1115-Ma-96	697450	5329000	Ma	Fi	1132-TB-96	687400	5318200	Till "B"	Fi
1116-TH-96	700500	5327900	Humus	Fi	1132-TC-96	687400	5318200	Till "C"	Fi
1116-TB-96	700500	5327900	Till "B"	Fi	1132-TM-96	687400	5318200	Till Bulk	Fi
1116-TC-96	700500	5327900	Till "C"	Fi	1132-TP-96	687400	5318200	Till Peb	Fi
1116-TM-96	700500	5327900	Till Bulk	Fi	1133-Ma-96	690200	5316750	Ma	Fi
1116-TP-96	700500	5327900	Till Peb	Fi	1134-Ma-96	691500	5317300	Ma	Fi
1117-Ma-96	700600	5327800	Ma	Fi	1137-Ma-96	695900	5329000	Ma	Fi
1118-Ma-96	703900	5329300	Ma	Fi	1138-Ma-96	704700	5325700	Ma	Fi
1119-Tm-96	702400	5323000	Till Bulk	Fi	1139-Ma-96	716100	5328300	Ma	Fi
1120-Ma-96	704300	5323100	Ma	Fi	1140-Ma-96	721100	5322000	Ma	Fi
1121-TH-96	708900	5325050	Humus	Fi	1141-Ma-96	710750	5318000	Ma	Fi
1121-TB-96	708900	5325050	Till "B"	Fi	1142-Ma-96	705950	5307550	Ma	Fi
1121-TC-96	708900	5325050	Till "C"	Fi	1143-Ma-96	703200	5307100	Ma	Fi
1121-TM-96	708900	5325050	Till Bulk	Fi	1144-Ma-96	694300	5307900	Ma	Fi
1121-TP-96	708900	5325050	Till Peb	Fi	1145-TH-96	693100	5310450	Humus	Fi
1122-Tm-96	711000	5321900	Till Bulk	Fi	1145-TB-96	693100	5310450	Till "B"	Fi
1123-TH-96	711050	5321700	Humus	Fi	1145-TC-96	693100	5310450	Till "C"	Fi
1123-TB-96	711050	5321700	Till "B"	Fi	1145-TM-96	693100	5310450	Till Bulk	Fi
1123-TC-96	711050	5321700	Till "C"	Fi	1145-TP-96	693100	5310450	Till Peb	Fi
1123-TP-96	711050	5321700	Till Peb	Fi	1146-Ma-96	693000	5310400	Ma	Fi
1123-TM-96	711050	5321700	Till Bulk	Fi	1151-TH-96	694700	5313950	Humus	Fi
1124-Ma-96	712600	5324700	Ma	Fi	1151-TB-96	694700	5313950	Till "B"	Fi
1125-Ma-96	713400	5327100	Ma	Fi	1151-TC-96	694700	5313950	Till "C"	Fi
1126-TH-96	723250	5319800	Humus	Fi	1151-TM-96	694700	5313950	Till Bulk	Fi
1126-TB-96	723250	5319800	Till "B"	Fi	1151-TP-96	694700	5313950	Till Peb	Fi

Appendix B: Material descriptions of type sections

This appendix includes section diagrams and material descriptions for:
a) subglacial till (p.62)
b) recessional moraine (p.63)
c) ice-contact stratified drift (p.64)
d) outwash (p.65)
e) glaciolacustrine sediments (p.66)

Diagram



	Material Description	Depositional Environment
Unit 1.	10 cm thick. Black. Humus. Contains abundant decomposed root and leaf matter. Lower contact wavy and clear.	Humus
Unit 2.	13 cm thick. Light grey. Silt. Platy. Lower contact wavy and diffuse.	Ae Horizon
Unit 3.	25 cm thick. Reddish brown. Sandy silt. Massive. Slightly compact. Lower contact wavy and diffuse.	"B" Horizon
Unit 4.	Greater than 50 cm thick. Dark yellowish brown. Silty sand. Fissile and compact.	"C" Horizon Lodgment Till

CL	Clay
Si	Silt
Ss	Sand
Grv	Gravel

▨	Humus	≡	Wavy, bedding
△	Till		

Subglacial till section showing development of Podzolic order soil profile. Site is located west of Hawk Junction.

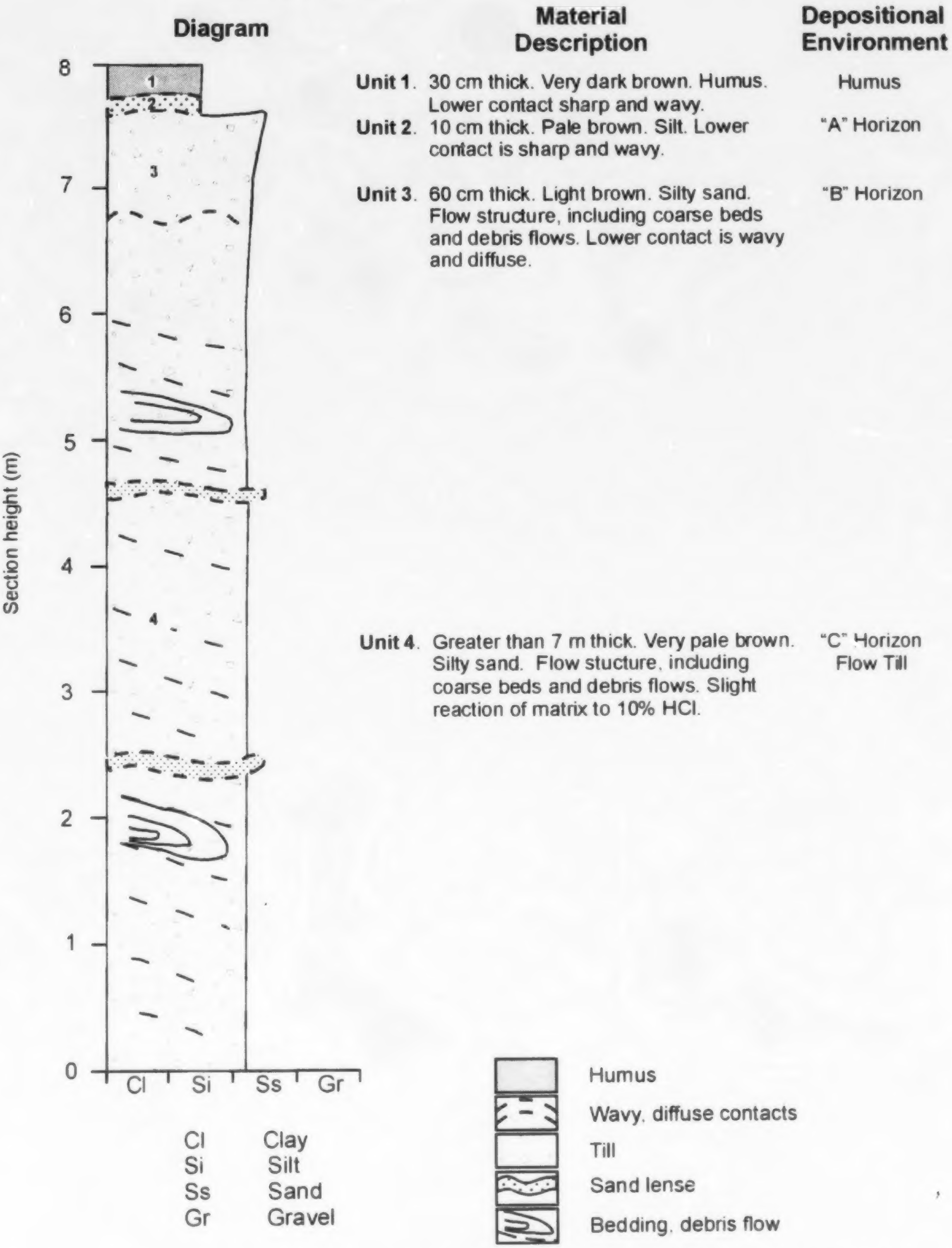
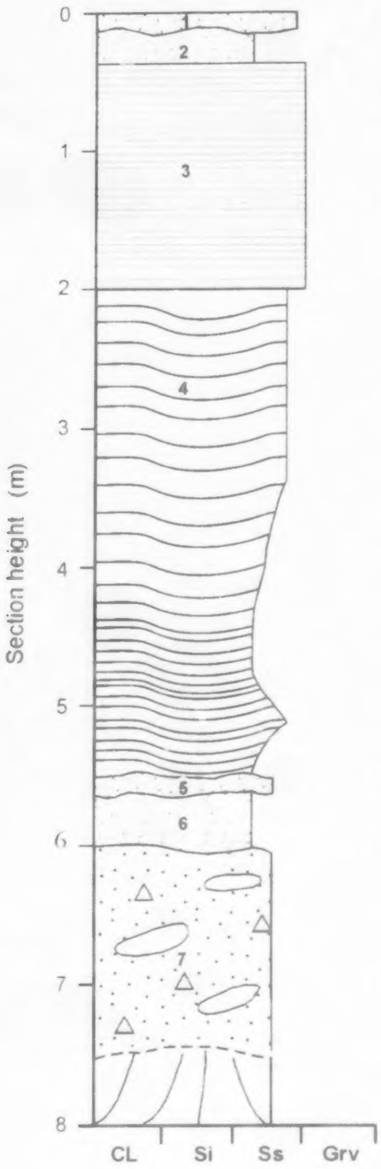


Diagram
Section height (m)
0
1
2
3
4
5
6
7
8
1
2
3
4
Cl
Si
Ss
Gr
Cl Clay
Si Silt
Ss Sand
Gr Gravel
Humus
Wavy, diffuse contacts
Till
Sand lense
Bedding, debris flow

	Material Description	Depositional Environment
Unit 1.	30 cm thick. Very dark brown. Humus. Lower contact sharp and wavy.	Humus
Unit 2.	10 cm thick. Pale brown. Silt. Lower contact is sharp and wavy.	"A" Horizon
Unit 3.	60 cm thick. Light brown. Silty sand. Flow structure, including coarse beds and debris flows. Lower contact is wavy and diffuse.	"B" Horizon
Unit 4.	Greater than 7 m thick. Very pale brown. Silty sand. Flow stucture, including coarse beds and debris flows. Slight reaction of matrix to 10% HCl.	"C" Horizon Flow Till

Section through a recessional moraine showing material types and soil horizons. Moraine is located west of highway 17 on Landrum Township road.

Diagram



	Material Description	Depostional Environment
Unit 1.	10 cm thick. Reddish brown. Cobbly sand. Massive, well rounded cobbles. Lower wavy and sharp.	Outwash
Unit 2.	21cm thick. Yellowish brown. Very fine sandy silt. Massive, compact, no reaction to 10% HCl. Lower contact sharp.	Till
Unit 3.	1.6 m thick. Dark greyish brown. Coarse sand. Upper few cm are massive, grading to planar bedded sand. Lower contact sharp.	Outwash
Unit 4.	31.6 m thick. Light yellowish brown. Sand. Upper 83 cm consists of coarse sand with planar beds and some ripples and fines downward over 2.17 m. Lower unit consists of 1.44 m of interbedded cycles of finer and coarser sand with low and high angled climbing ripples.	Outwash
Unit 5.	12 cm thick. Dark greyish brown. Coarse pebbly sand. Massive and loose. Lower contact clear and wavy.	Outwash
Unit 6.	38 cm thick. Greyish brown. Silty sand. Massive and compact, reacts strongly with 10%HCl. Lower contact wavy and clear.	Till
Unit 7.	Greater than 5 m thick. Greyish brown. Coarse pebbly sand. Massive and loose.	Outwash
		Coliuvium

CL	Clay
Si	Silt
Ss	Sand
Grv	Gravel

▨ Gravel bed

☐ Till

☰ Planar bedding

≋ Wavy bedding

▨ Coarse, dirty outwash

▥ Colluvium

Section through ice-contact stratified drift. Site is located at the southwest end of Hawk Lake.

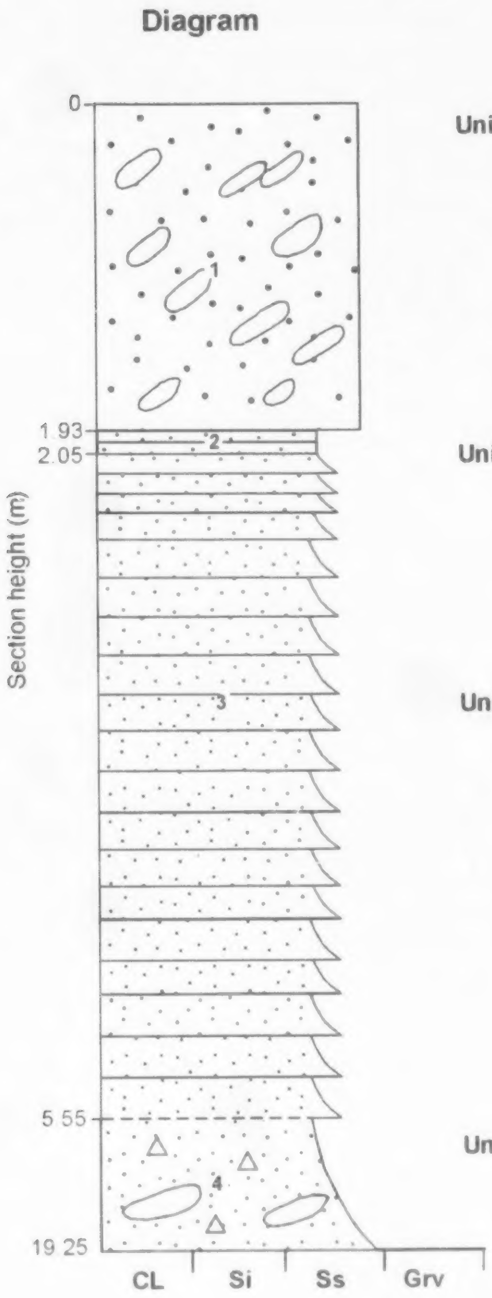


Diagram
Section height (m)
0
1.93
2.05
5.55
19.25
1
2
3
4
CL
Si
Ss
Grv
GRAIN SIZE

Material Description	Depositional Environment
Unit 1. 1.9 m thick. Pale brown. Cobbly, coarse sand. Massive, slightly cemented with calcium carbonate.	Outwash
Unit 2. 15 cm thick. Pale brown. Coarse sand. Planar laminated. Lower contact sharp.	
Unit 3. 3.5 m thick. Pale brown. Cobbly sand. Planar bedded, dip gently west. Lower contact diffuse.	Outwash
Unit 4. Greater than 13.7 m. Pale brown. Boulder rich gravel with a coarse and matrix. Massive and loose.	Outwash

CL	Clay
Si	Silt
Ss	Sand
Grv	Gravel

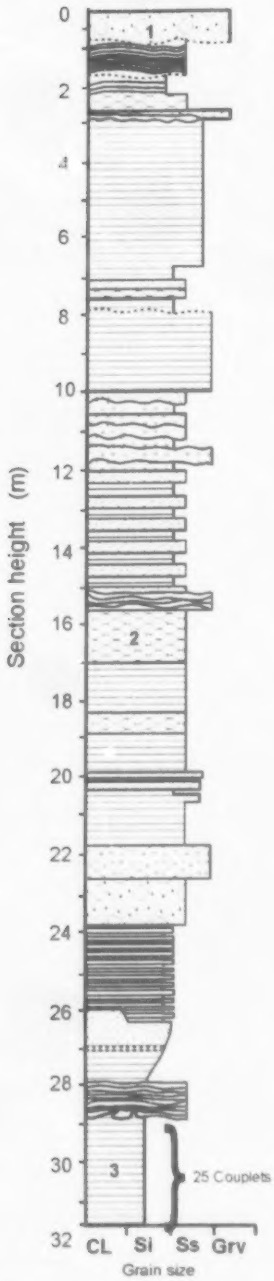
▨ Gravel bed

☰ Planar sand beds

▨ Coarse, poorly sorted sand

Outwash section. Located south of Hawk Junction.

Diagram	Material Description	Depositional Environment
	Unit 1. 1 m thick. Brown to dark brown. Coarse sand and boulders. Massive and loose. Lower contact is abrupt and smooth.	Delta Topset Beds
	Unit 2. 28m thick. Alternating beds of pale brown coarse sand, brown sand and light grey fine sand. Thickness of beds varies between 2 and 30 cm. Massive to planar beds in the coarse sand, planar beds to trough cross bedding in the fine sand. Numerous fining up sequences in the fine sand. Lower contact with the coarse sand is smooth and clear, with the sand gradual and diffuse.	Deltal Forset Beds
	Unit 3. 2.5 m thick. Alternating beds of dark grey silt and light grey clay. Silt layers 3 to 4.5 cm thick, clay layers 0.5 to 2 cm thick. Each couplet 25 cm thick. Contacts between layers sharp and smooth.	Deep Water Sedimentation



CL	Clay
Si	Silt
Ss	Sand
Grv	Gravel

⛆ Gravel bed

■ Wavy, planar bedding

▤ Trough cross bedding

☰ Planar beds

☐ Foreset beds

☐ Massive bed

〰 Diffusely bedded sediments

⛆ Gravelly sand

Glaciolacustrine sediments exposed in a section through a Magpie River valley terrace.

Metric Conversion Table

Conversion from SI to Imperial			**Conversion from Imperial to SI**		
SI Unit	*Multiplied by*	*Gives*	*Imperial Unit*	*Multiplied by*	*Gives*
			LENGTH		
1 mm	0.039 37	inches	1 inch	**25.4**	mm
1 cm	0.393 70	inches	1 inch	**2.54**	cm
1 m	3.280 84	feet	1 foot	**0.304 8**	m
1 m	0.049 709	chains	1 chain	20.116 8	m
1 km	0.621 371	miles (statute)	1 mile (statute)	**1.609 344**	km
			AREA		
1 cm^2	0.155 0	square inches	1 square inch	**6.451 6**	cm^2
1 m^2	10.763 9	square feet	1 square foot	**0.092 903 04**	m^2
1 km^2	0.386 10	square miles	1 square mile	2.589 988	km^2
1 ha	2.471 054	acres	1 acre	0.404 685 6	ha
			VOLUME		
1 cm^3	0.061 023	cubic inches	1 cubic inch	**16.387 064**	cm^3
1 m^3	35.314 7	cubic feet	1 cubic foot	0.028 316 85	m^3
1 m^3	1.307 951	cubic yards	1 cubic yard	0.764 554 86	m^3
			CAPACITY		
1 L	1.759 755	pints	1 pint	0.568 261	L
1 L	0.879 877	quarts	1 quart	1.136 522	L
1 L	0.219 969	gallons	1 gallon	**4.546 090**	L
			MASS		
1 g	0.035 273 962	ounces (avdp)	1 ounce (avdp)	28.349 523	g
1 g	0.032 150 747	ounces (troy)	1 ounce (troy)	**31.103 476 8**	g
1 kg	2.204 622 6	pounds (avdp)	1 pound (avdp)	**0.453 592 37**	kg
1 kg	0.001 102 3	tons (short)	1 ton (short)	**907.184 74**	kg
1 t	1.102 311 3	tons (short)	1 ton (short)	**0.907 184 74**	t
1 kg	0.000 984 21	tons (long)	1 ton (long)	**1016.046 908 8**	kg
1 t	0.984 206 5	tons (long)	1 ton (long)	**1.016 046 90**	t
			CONCENTRATION		
1 g/t	0.029 166 6	ounce (troy)/ ton (short)	1 ounce (troy)/ ton (short)	34.285 714 2	g/t
1 g/t	0.583 333 33	pennyweights/ ton (short)	1 pennyweight/ ton (short)	1.714 285 7	g/t

OTHER USEFUL CONVERSION FACTORS

	Multiplied by	
1 ounce (troy) per ton (short)	31.103 477	grams per ton (short)
1 gram per ton (short)	0.032 151	ounces (troy) per ton (short)
1 ounce (troy) per ton (short)	20.0	pennyweights per ton (short)
1 pennyweight per ton (short)	0.05	ounces (troy) per ton (short)

Note: Conversion factors which are in bold type are exact. The conversion factors have been taken from or have been derived from factors given in the Metric Practice Guide for the Canadian Mining and Metallurgical Industries, published by the Mining Association of Canada in co-operation with the Coal Association of Canada.

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